Market Study on

Artificial Insemination and Vaccine Production Value Chains

In Kenya

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Executive Summary

This report responds to the terms of reference from the Kenya Dutch Embassy with the broad objectives to identify constraints to effectiveness, efficiency and growth in the AI and VP value chains, and to ultimately identify opportunities for the Dutch private sector to invest in the AI and VP value chains. Based on desk studies and stakeholder interviews and questionnaires in the AI and VP value chains, there is substantial information on the AI compared to the VP value chain. As a result of commercial interests' protection, there is reticence on release of vaccine production and distribution statistics. Given this experience, we estimated the statistics based on interviews and empirical livestock population data.

The current total value of the Kenya AI business exceeds 11 million USD at the current 18% of total dairy cattle breedings with a potential to generate over 37.6 million USD at 60% of total dairy cattle breedings. AI use is predominant in dairy cattle while less than 1% of the beef herd is bred using AI. The AI use is projected to grow by 1.5% to 5% in the Kenya dairy herd to reach up to 2.3 million inseminations per year by 2023 compared to the current 650,000. Consistent with privatization of AI service delivery, as much as 95% inseminations are now conducted by private AI service providers and cooperatives. In addition, semen imports increased from 20% of semen distributed in the 1990s to the current 40% of the semen distributed. This bodes well for private sector semen distribution market share growth. Both semen distribution and AI service provision generate sufficient returns to guarantee business growth. However, returns on investment for semen production business may not be guaranteed unless the critical number of doses of about 3 million per annum are produced.

Of concern has been the market distortion from parastatals engaged in semen production (KAGRC) and vaccine production (KEVEVAPI) that charge subsidized prices and are not subject to import levies and taxes and product quality checks and standards applied to imported AI and vaccine products. Inefficient semen and vaccine production is prevalent in these parastatals which creates opportunities for partnerships with competent, well-resourced private sector players to improve production efficiency.

The value of the vaccine business is currently estimated to be about 13 million USD per annum. Projections are difficult to compile because demand for vaccines has been unpredictable partly because it has largely been influenced by sporadic disease outbreaks and there is no central vaccine distribution data repository. The current annual vaccine business at KEVEVAPI is valued at about 3 million USD. It is estimated that private sector alone commands an annual 10 million USD vaccine business; however, in the absence of a central vaccine distribution data repository and reticence from private vaccine distributors this could not be confirmed in this study.

While the market for AI supplies and services is well defined and relatively more developed, the market for vaccines is ill-defined and not predictable and is largely dependent on disease outbreaks. Based on the populations of livestock, there is grossly limited vaccine distribution. It is obvious that a cattle population of 27 million would require annual vaccine doses in excess of this population but KEVEVAPI supplied a total 27 million doses of vaccines for all the livestock species which clearly shows a huge gap in vaccine supply. The demand for vaccines would be multiple times higher than current demand. It is apparent that vaccine availability, efficiency of distribution, and farmer knowledge on vaccine use are inadequate. Both KEVEVAPI and the GoK accept that the national and regional demand for vaccines is not being met. This demand is likely to be met when KEVEVAPI engages partners that can improve its capacity including a technological upgrade of its facilities.

While there is anecdotal evidence of a potential vaccine demand, such investment opportunities would be more apparent if the GoK establishes vaccine production and distribution data recording systems. Apart from this GoK expectation, stakeholders in the VP sub-sector could also establish farmer needs and demand from created stakeholder forums.

Investment in semen and vaccine production levels can be considered, but initial investment by Dutch companies should first be at the warehousing and distribution level (supply through product importation) to establish distribution channels and demand before investing in production facilities. Strategically, it is essential for Dutch investors to work with local partners to understand the markets before fully engaging and making heavy investments. All breeding products from semen to supplies should be tailored to the markets for pack size/specifications. However, these companies can consider investing in local AI companion product manufacture.

Given that breeding programs take long to realize results, this makes the AI sub-sector vulnerable to public sector and donor funded programs that often distort markets. In this regard, it is important to scope the NGOs working in the area to form strategic buying-down risk partnerships or alliances, and hence preclude market distortions.

It is purported that Dutch companies have interest in investing in the Kenya AI and VP value chains, but based on activities of the companies there is more interest and presence in the AI than the VP value chain. It is also apparent that most Dutch pharmaceutical and vaccine companies have merged with large international companies, mostly American companies. It is therefore probable that this may dilute the Dutch agenda of tapping the vaccine business in Kenya.

In general, if Dutch companies are interested in production business they should set-up in existing institutions such as KEVEVAPI and KAGRC bull stud. As suggested by some Dutch companies, a precondition for partnership with public sector institutions is operation according to a commercial and realistic business model. Such model operates free of subsidies and government interference. Dutch companies should also consider investing in after sales service provision for specialized equipment and special technology to existing institutions (e.g., liquid N generation equipment after sales service). As a result of high import duties, Dutch companies should consider importing raw materials or singular vaccines that are blended locally as done by some local companies.

Dutch companies should exploit existing bilateral agreements between the Dutch Government and the GoK; for example, the heifer supply agreement. Finally, because the AI and vaccine businesses are largely anchored on the dairy sub-sector, the major changes in the sector that include the advent of international milk processors such as Danone and Brookside joint venture, investors should be prepared for long-run business model modifications.

Foreword

Kenya has one of the largest dairy herds in Africa and there is a high market demand for dairy products at both the national and regional level. Milk production is however not sufficient to meet this ever growing demand and for that reason development of the dairy industry in the region has enormous potential. But the industry is also facing challenges. There is a large gap between milk yields in East Africa and in developed countries, mainly due to poor management, poor feeding regimes and poor cow breeds. To remain competitive and meet the demand, Kenya will have to address these challenges and will need dairy cows with a higher milk production.

The Embassy of the Kingdom of The Netherlands in Kenya supports various initiatives to improve the dairy sector as part of the new policy agenda linking trade and development. The SNV Kenya Market-led Dairy Programme (KMDP) is instrumental in a stronger, more efficient, effective and inclusive value chain and addresses systemic issues that hamper growth of the sector, such as inadequate dairy farm management, feed production, milk collection, processing and milk quality. Furthermore, through government-to-government cooperation, export of heifers from The Netherlands to Kenya is now possible. Dutch companies in the dairy sector, aware of the opportunities for dairy development in the East African region, are eager to invest in the Kenyan dairy sector, as witnessed by trade missions of the Dutch Dairy Development Partners (DDDP), a consortium of Dutch dairy companies with international ambitions.

The quality of cow breeds (adapted to the local situation) and animal health are important determinants of the productivity of dairy cows. Improvement of the cow genetics - through artificial insemination (AI) - and vaccine production in Kenya are however subject to constraints to effectiveness, efficiency and growth that limit the performance of the dairy sector. Given Dutch investor interest in the Kenyan dairy sector, the Dutch Ministry of Economic Affairs through the office of the Agricultural Counsellor commissioned a market study on the two value chains. The market study was conducted by African Breeders Services Total Cattle Management Limited (ABS TCM Ltd), a leading provider of quality genetics and related products to farmers in East and Southern Africa.

This market study gives a detailed overview of the AI and vaccine production value chains, including constraints and areas for improvement. Also, the study identifies investment opportunities and possibilities for Dutch businesses to partner with Kenyan stakeholders. I trust this study will increase the interest of the Dutch private sector to pursue such opportunities, in so doing contributing to improved performance of the Kenyan dairy sector and increased trade between Kenya and The Netherlands.

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Embassy of the Kingdom of The Netherlands – Nairobi, Kenya

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LIST OF ABBREVIATIONS

ABSTCM	African Breeders Service Total Cattle Management Limited
ADC	Agriculture Development Corporation
AHITI	Animal Health Industry training Institutes Artificial Insemination
AI	Artificial Insemination
AISPs	Artificial Insemination Service Providers
ASAL	Arid and Semi Arid Lands
BOC	British Oxygen Company
BSMDP	Business Services for Market Development Project
CAK	Consumer Association of Kenya
CDC	Centre for Disease Control
CET	EAC Customs Union's Common External Tariff
COMESA	Common Market for Eastern and Southern Africa
DFID	Department of Foreign International Development
DIY	Do It Yourself
DTI	Dairy Training Institute
DVS	Director of Veterinary Services
EAAPP	East Africa Agricultural Productivity Project
EAC	East African Community
EASETA	East Africa Society for Embryo Transfer Association
ECFITM	East Coast Fever Infect and Treat Method
EBIT	Earning Before Income Tax
GDP	Gross Domestic Product
GoK	Government of Kenya
IGAD	Inter Governmental Authority on Development
KDFF	Kenya Dairy Farmers Federation
KFA	Kenya Farmers Association
KAGRC	Kenya National Animal Genetic Resource
KALT	Kenya Association of Livestock Technicians
KARI	Kenya Agricultural Research Institute
KENDAPO	Kenya National Dairy Association of Producers
KBS	Kenya Bureau of Standards
KDB	Kenya Dairy Board
KES	Kenya Shillings
KEVEVAPI	Kenya Veterinary Vaccine Production Institute
KLBO	Kenya Livestock Breeders Organization
K-LIFT	Kenya Livestock Finance Trust
KLRI	Kenya Livestock Research Institute
KNBS	Kenya National Bureau of Statistics
kW/h	Kilo Watt Hour
KWFT	Kenya Women Finance Trust
LGSEA	Livestock Genetic Society of East Africa
NGOs	Non Governmental Organizations
MCC	Milk Collection Centre

MLD	Ministry of Livestock Development
MVE	Minnesota Valley Engineering
NLBI	National Livestock Breeding Institute
PSI	Pounds per Square Inch
USD	United States Dollar
VAT	Value Added tax
VP	Vaccine Production
YDS	Chinese Liquid Nitrogen Tank

CHAPTER 1: INTRODUCTION AND TERMS OF REFERENCE

1.1 Background to Report

The Kenya dairy sector is of key interest to The Netherlands due to the country's competitive knowledge and expertise. Among others, some of the key sub-sectors necessary for strong performance of the Kenya dairy sector include artificial insemination (AI) and vaccine production (VP) for the control and prevention of animal diseases. Several Dutch enterprises have shown interest in investing in the Kenyan dairy and a number of them have already set up shop in Kenya. In order to further improve the dairy sector, there is need for the AI and VP value chains to be organized effectively and efficiently. This market study aims to identify those areas for improvement in the AI and VP value chains where the Dutch private sector can invest in.

1.2 Broad and Specific Objectives

The broad objectives of the study are to identify constraints to effectiveness, efficiency and growth in the AI and VP value chains, and to identify opportunities for the Dutch private sector to invest in the AI and VP value chains. The specific objectives are as follows:

a) Investigate the current state of AI and VP:
   a) Statistics, market supply and demand, trends and projections
   b) Policy and regulatory framework impacting on AI and VP value chains, including import regulations
   c) Map the AI and VP value chains
   d) Map distribution channels of semen and vaccines
   e) Map local production vs. imported semen and vaccines
   f) Constraints

b) Identify opportunities for the Dutch private sector to invest in AI and VP:
   i. Needs assessment
   ii. Specific opportunities based on needs and bottlenecks

It is anticipated that the results of the study will inform the Dutch private sector that is interested in investing in the Kenyan dairy sector and, in particular, the AI and VP sub-sectors about investment opportunities and possibilities for partnership with Kenyan stakeholders, which can lead to Kenyan dairy sector improvements and increased trade between the two countries. The study will inform Dutch companies and knowledge institutions about entry points for investment or knowledge transfer. Lastly, it will recommend action plans with steps to take to improve the sector and how the Dutch private sector can be involved in this.

1.3 Report Structure

Excluding the pre-report section, this report consists of 5 chapters, Chapter1 - Introduction and Terms of Reference, Chapter 2 – The Kenyan Business Environment, Chapter 3 - Current State of AI Sub-sector, Chapter 4 – Current State of the VP Sub-sector, Chapter 5 - Analysis of Investment Opportunities in the AI and VP Value Chains, and Chapter 6 – Conclusion and Recommendations. Chapter 1 subsumes the terms of reference.

Chapter 2 presents, through PESTLE analysis, the business macro-environment that is likely to influence the AI and VP businesses. Chapter 3 presents the current state of the AI sub-sector. Specifically, it presents national AI statistics, the AI value chain, financial analysis of the AI businesses at various levels of the chain, and a general analysis of the investment opportunities in the AI value chain. This approach was selected because it gives the value chain context first, followed by analyses and then recommendations.

Similarly Chapter 4 presents the current state of the VP sub-sector and specifically addresses and presents the VP value chain, a SWOT analysis of the sub-sector, and a general analysis of the investment opportunities in the VP value chain. This approach was selected for the same reasons as for the AI value chain.

Chapter 5 highlights investment opportunities in the AI and VP sub-sectors. Specifically the chapter addresses the potential Dutch private sector opportunities for investment in the AI and VP value chains, potential AI and VP value chain segments for investment, conducive factors for investment, investment constraints, entry barriers, and competition, potential AI and VP value chain investment risks, strategies to address constraints and enhance investment opportunities, and potential complementarity of AI and VP value chains.

Chapter 6 concludes the report and presents the conclusion and general recommendations, particularly on the end point – opportunities for Dutch private sector investment.

1.4 Study Methodology

This study was conducted from desk studies and other secondary information and data sources which gave rise to the inception report. Based on the inception report findings interviews of key respondents were conducted and questionnaires distributed to some Kenyan and Dutch respondents (Appendices 2 & 3). A total of five Dutch companies and four experts were contacted and served with questionnaires (Appendices 4, 5 & 6) but two experts were interviewed. However, questionnaire responses were received from two companies and one expert. None of the Dutch vaccine experts and companies responded to the questionnaires. After the draft report was compiled, a roundtable discussion with key Kenyan AI and VP stakeholders was convened at the Kenya Dutch Embassy (Appendix 7).

CHAPTER 2: KENYA BACKGROUND INFORMATION ON THE BUSINESS ENVIRONMENT: PESTLE ANALYSIS

The following PESTLE analysis of Kenya was carried out to assess the impact of political, economic, socio-cultural, environmental and other external influences.

2.1 Political

The Kenya Government type is a Republic and is stable with last elections held peacefully in 2013. Kenya also adopted a new constitution in 2010 that has led to a devolved governance system which introduced county governments. The Kenya President has been recently acquitted for International Criminal Court case on human rights abuses during the 2007 post-election violence. There are no major likely changes in the political environment.
Compared to most Africa countries, Kenya enjoys freedom of press, but rule of law is weak and levels of bureaucracy and corruption are of concern.
Kenya tax policies, fiscal policy, trade tariffs are outlined in the Kenya Fiscal Guide 2013/2014 (www.kpmg.com). Kenya is a member of the World Trade Organization (WTO), the Common Market for Eastern and Southern Africa (COMESA), and the East African Community (EAC) and applies the EAC Customs Union's Common External Tariff (CET) on most tariff lines.

2.2 Economic

Kenya's GDP accounts for 40% of the East African region's GDP making it the largest economy amongst the members of EAC. Kenya also boasts the most sophisticated agricultural sector. The recent discovery of resources such as oil, base titanium, coal, and underground water, augur well for the country's future economic performance.
Kenya currency exchange control was liberalized in 1994; however, there is a requirement to report all financial cash transactions above USD10,000 to the Financial Reporting Centre as a measure to curb money laundering. The major instrument for attraction and protection of foreign investment is the Foreign Investment Protection Act. Kenya has also instituted the Industrial and Promotion Advisory Centre to assist approved investors with investment procedures. There are no sectors or regions reserved for nationals to the exclusion of foreign investors. However, foreign investment in agriculture is controlled if it entails land ownership or leasing.

In 2013 the Government widened the range of goods that is subject to the 16% value-added tax. Also, the government is reintroducing a capital-gains tax in January 2015. Kenyan county governments are proposing to impose new taxes on many items thus creating an increasingly unpredictable environment for investors.

Kenya middle class households are estimated at 0.4 million. The country now has more than 50 supermarket retail stores countrywide (e.g., Nakumatt and Uchumi) reflecting increasing demand for retail products from an ever increasing middle class population.

Prime interest rate has been high while the exchange rate has been unstable (Kenya shilling (KES) vs hard currencies). This has partly been a consequence of insecurity posed by the Al Shabab terrorist militia causing flight to safety tendencies and reducing inflows from tourism sector as well as exports. The tourism sector is a key contributor to the economy and a foreign currency earner. Also, erratic weather patterns often negatively affect food production, leading to food imports. This has implications on raising the national import bill and widening Current Account Deficit if exports growth remains low.

Table 1: Kenya economic statistics for the period December 2013 to December 2014	
Item/Description	**Value**
Prime Interest Rate (Dec. 2013 to Dec. 2014)	16.99 to 16.00 %
USD Exchange Rate (Feb. to Dec. 2014)	KES 86.26 to 90.40
Inflation (Jan. to Nov. 2014)	7.21 to 6.09%
GDP (Dec. 2013 to Dec. 2014)	4.4 to 4.0%

Inflation rate is currently 6.09% but at one point it was as low as 3.18% and also reached a peak of 31.5% The consumer price index is currently 151.85 with the lowest recorded being 99 and the highest was 152.24.

2.3 Social

The Kenya population growth rate is 2.11% and has 33% of population in the 25 to 54 year age group.

The rates of literacy and urbanization are 87.4% and 4.36%, respectively. The Kenya adult literacy rate is the highest in East Africa. Investment in education and health expenditure is 6.7% and 4.5% of GDP, respectively.
Social mobility in Kenya is a result of tribal conflicts, cattle rustling, Al Shabab terror threats, search for employment in sugar, tea, coffee and other plantations, and refugees fleeing wars in neighbouring countries.

2.4 Labour and Employment

The challenges faced in the Kenya labour market were summarized by KIPPRA (2013) and include the following:

- High youth unemployment with respective unemployment rates for the 15 to 35 and 15 to 24 years age groups of 10.4 and 14.2%;
- High levels of under-employment;
- High levels of employment in the informal sector, especially in rural areas; and
- Kenya labour force has relatively low education attainment compared to middle income countries. Most people are employed as smallholder farmers and the major challenge is low education exacerbated by poor extension services. In Kenya, during the last five years 61.1% of the workforce was employed in agriculture.

2.5 Technological

Kenya is a leading IT country in East Africa and is ranked the world's number one in mobile money transactions. Mpesa is the flagship mobile phone banking product. It put Kenya at the forefront of mobile money transfers and mobile banking services. Mpesa's success in Kenya is attributed to several factors:

- Need to provide a solution to the high cost of sending money from one place to another;
- Presence of Safaricom, a dominant player in the market which was able to develop an efficient agent network;
- Support from the Central Bank of Kenya which is the regulatory body that advocated for regulation to support innovation.

In addition, Kenya has several IT innovations for Agriculture and industries including the iCow dairy extension application and the iHub innovation platform for IT solutions and youth incubation programs.
The East Coast Fever-Infect and Treat Method (ECF-ITM) live vaccine was first produced at the International Livestock Research Institute (ILRI) in Kenya and is now widely used in East and southern Africa. Kenya also boasts of the largest bull stud in Africa, the Kenya Animal Genetic Resource Centre

(KAGRC). Under the East Africa Agriculture Productivity Program (EAAPP) funded by the World Bank, Kenya has been selected as the regional Dairy Centre of Excellence.

2.6 Legal

In Kenya, employment is governed by the general law of contract, as much as by the principles of common law. A number of laws have been passed specifically dealing with different aspects of the employer-employee relationship. These laws define the terms and conditions of employment, and consist mainly of four Acts of Parliament:

- The Employment Act (2007);
- Regulation of Wages and Conditions of Employment Act (2007);
- The Factories Act (Cap. 514); and
- The Work Injury Benefits Act (2007).

The Kenya Constitution prohibits foreigners from holding freehold land title anywhere in the country, but allows leasehold titles of up to 99 years. The 2010-2011 Global Competitiveness Index (World Economic Forum, 2011) cited corruption, limited access to financing, and inadequate infrastructure as the three most problematic factors for doing business in Kenya. Corruption remains a substantial trade barrier in Kenya. Investor firms find it difficult to succeed against competitors who are willing to ignore or engage in corruption. Although the Kenyan judicial system is working to improve its efficiency and timeliness, a backlog of cases, including those that are investment-related, burdens the system. Corruption, both perceived and real, reduces the system credibility.

Kenya's lax enforcement of intellectual property rights continues to be a serious challenge. Pirated and counterfeit products in Kenya, mostly imported from Asia, present a major impediment to business interests. At times transit goods and corruption at Export Processing Zones can lead to counterfeit products on the market. Kenya passed the Competition Act No. 12 of 2010 and the Competition Authority of Kenya (CAK) legislation for consumer and industry actors' protection. The CAK mandate is to promote and safeguard competition in the national economy and to protect consumers from unfair and misleading market conduct.

2.7 Environmental

The Environmental Act EMCA of 1999 provides guidelines for environment custodianship.

The business environmental analysis for Kenya is detailed in an economic overview of Sub-Saharan Africa (World Bank, 2014). Kenya is a low income country with a population of 44.4 million and per capita gross national income of USD 930. Based on the 2015 assessment on ease to do business Kenya is ranked 136 a change of 1 from 137 in 2014. Also, Kenya has a 0.4 change in distance to frontier score from 54.6 in 2014 to 55 in 2015. In fact, Kenya ranks fourth on ease to do business in East Africa.

Kenya's strengths include:

- Plays a pivotal role in East African Community, a leading African common market in sub-Saharan Africa;
- Diversified agriculture (maize, tea, coffee, horticulture);
- Good telecommunications and financial services;
- Lively demographics and emergence of a middle class; and
- Adoption of a new more business friendly constitution in 2010.

The weaknesses can be summarized as:

- Agricultural production is rain fed and thus highly dependent on weather conditions;
- Inadequate infrastructures hinders economic development;
- Widespread poverty;
- Governance improving but persistent corruption; and
- Major terrorist risks due to the difficult geopolitical situation.

CHAPTER 3: CURRENT STATE OF THE ARTIFICIAL INSEMINATION (AI) SUB-SECTOR

The Government of Kenya (GoK) last carried out a comprehensive livestock census in 1967; as a result, data on livestock has largely been derived from triangulations and official sales records. Unfortunately, informal trade and household consumption statistics have not been included. However, in 2011, the Intergovernmental Authority on Development (IGAD) and the Kenyan National Bureau of Statistics (KNBS) completed a joint review of the importance of livestock to the Kenyan economy. The study demonstrated that the livestock contribution to Kenyan agricultural GDP was more than two and a half times larger than the official estimate for 2009, the most recent year for which there was complete data (IGAD LPI Working Paper No. 03-11) (Table 2).

Table 2: Kenyan livestock populations - old and new estimates

Livestock	National Ministry of Livestock Development 2008 estimates	National 2009 population census	Percentage underestimate of 2008 estimate
Cattle	13,522,500	17,467,774	23
Sheep	9,907,300	17,129,606	73
Goats	14,478,300	27,740,153	92
Camels	1,132,500	2,971,111	162
Donkeys	786,800	1,832,519	57
Pigs	330,020	334,689	1
Chicken indigenous	29,615,000	25,756,487	7
Chicken commercial		6,071,042	

Source: IGAD LPI Working Paper No. 03-11

3.1 AI Statistics

The main Kenya livestock species include dairy and beef cattle, pigs, sheep, goats, poultry and camels. AI is largely in dairy cattle using deep frozen and fresh bull semen. However, there have been records of AI in pigs using fresh semen (99% of all inseminations), in goats using imported deep frozen semen, and in poultry on a few commercial breeding farms. AI has also been used to a small extent in horses and breeding dogs by horse breeders and security companies, respectively.

This section will focus mainly on dairy cattle AI which is the most predominant. The Kenya national cattle population is now estimated to be 18 million and the improved dairy breed cattle population is estimated at 3.5 million head making up 19% of the national cattle herd (Makoni et al., 2014). The dairy contribution to national GDP is 8%. There are three main beef cattle production systems in Kenya: nomadic pastoralism, agro-pastoralism and ranches. Nomadic pastoralism and agro-pastoralism contribute about 65% of total beef output in Kenya, while the rest is obtained from ranches and a small proportion of dairy-cull cattle (Omiti and Irungu, 2002). It is estimated that over 60 percent of livestock in Kenya is kept by pastoralists in the arid and semi-arid lands (Otieno et al., 2012). Only 18% of the dairy herd is bred by AI and less than 0.05% of the beef cattle are under AI programs (Makoni et al., 2014). As of 2004, there were only eight beef cattle bulls at the KAGRC, which is an indication of either low priority or low demand for beef cattle genetic material. This may also be explained by the low use of AI in the multiplication of beef cattle (Gamba, 2006).

3.1.1 Statistics on livestock species and populations with potential for AI use

Table 3 shows Kenya cattle breed percentage distribution across provinces (Tegemeo, 2006). However, the Kenya governance system has since devolved to a County system (Appendix 8). The largest cattle numbers are in the Central, Rift Valley and Nyanza provinces.

Table 3: Cattle breed distribution across former Provinces of Kenya (%)

Breed	Nyanza	Western	Eastern	Rift Valley	Central
Local Zebu	41.52	21.64	20.47	15.2	1.17
Cross breed (< 50% exotic dairy genetics)	18.79	8.05	3.36	46.98	22.82
Cross breed (50%)	17.72	8.23	3.38	39.97	32.28
Cross breed (> 50% exotic dairy genetics)	11.91	5.43	2.17	31.77	48.74
Pure Friesian	3.55	0.71	4.96	2.82	65.96
Pure Ayrshire	5.26	4.21	3.16	16.84	70.53
Pure Sahiwal	0	0	0	50	50
Pure Jersey	0	9.09	18.18	27.27	45.45
Pure Guernsey	9.09	0	4.55	13.64	72.73
Pure Boran (local)	14.71	47.06	2.94	35.29	0
Other pure exotic	0	0	0	0	100
Total	16.68	9.35	6.22	29.59	38.17

Source: Tegemeo Household Survey 2004

3.1.2 Statistics on current demand and supply of local and imported semen for important livestock species

The statistics on current demand and supply of local and imported semen largely exists for dairy cattle and, to a smaller extent, beef cattle. As reported above, the national percentage use of AI in the Kenya dairy sector is estimated at 18% (Makoni et al., 2014; CAK Report, 2014). Local supply of semen is from KAGRC and currently stands at 650,000 units per year and, until recently, represented more than 80% of national AI use with about 20% supplemented by imports. Data for Years 2013 to 2014 is now indicating an increase in imported semen market share which now stands at 350,000 semen units which is just over 40% of national AI use.

The estimated potential supply gap is 1,600,000 units (doses) of dairy semen and 15,000 units of beef semen at 1% of beef population using AI. Therefore, based on current livestock data that Kenya dairy cattle population is 3.5 million and given that the current dairy cattle inseminations only represent 18% of the dairy cattle population, Kenya potential annual demand for dairy cattle AI stands at about 630,000 units. Potential dairy semen demand at the possible 60% of cattle breedings is estimated to be 2.1 million units.

3.1.3 Trends in semen demand and supply over the last 10 years and projections for the next 10 years

The recorded annual inseminations averaged about 1.7 million from 2006 to 2013 (Table 4). Most of these inseminations were conducted in the former Central Province.

Table 4: Total recorded eight-year (2006 to 2013)cattle inseminations carried out by private AISPs and the Kenya National Artificial Insemination Service (KNAIS) per Province and provincial percent share

Province	Private	KNAIS	Total AI	% Total AI
Central	1,195,459	0	1,195,459	71
Rift Valley	233,620	669	234,289	14
Eastern	173,776	3,182	176,958	10
Western	19,402	13,917	33,319	2
Coast	40,591	452	41,043	2
Nyanza	8,689	1,498	10,187	1
Nairobi	1,786	2,571	4,357	0
Total	**1,673,323**	**17,147**	**1,690,470**	**100**

The former Central Province of Kenya (now Kiambu, Kirinyanga, Murang'a, Nyandarua and Nyeri counties) commanded 71% of AIs while the rest of the provinces accounted for 29% of the inseminations. The proximity of local semen production at KAGRC, located in the former Central Province, positively influenced AI adoption in the Province. Specifically, proximity to KAGRC facilitated quick access to breeding inputs including semen, AI consumables and liquid nitrogen.

Consistent with liberalization of the economy, during the last eight years the public sector AI services provision declined (Figure 1). In this regard, the role of the KNAIS declined.

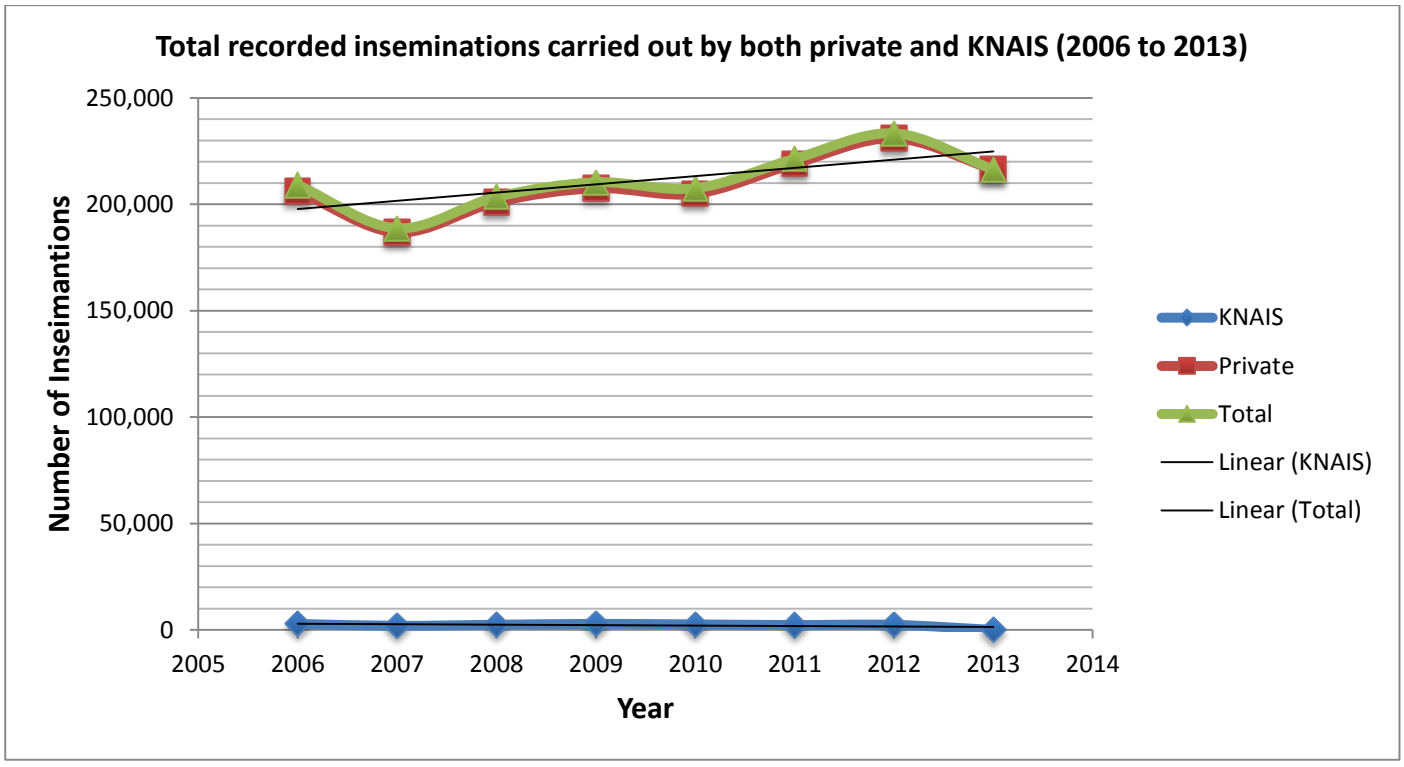

Figure 1: Total recorded cattle inseminations carried out by both private AISPs and KNAIS (2006 to 2013)

Total recorded inseminations, illustrated in Figure 1, indicate that the privatization of AI services initiated in 1991 resulted in almost all inseminations being carried out by private artificial insemination service providers (AISPs), cooperatives and commercial farmers. According to the CAK Report (2014)

usage of AI is in the range 18 to 27% of total cattle breedings; 83% of the inseminations is carried out by private inseminators, 13% by dairy cooperatives and <4% by the public sector.
Projections for the next 10 years indicate an increase in inseminations that will also increase imported and local semen supplies (Figure 2). Annual increase for both local and imported semen demand will range from about 6 to 9%

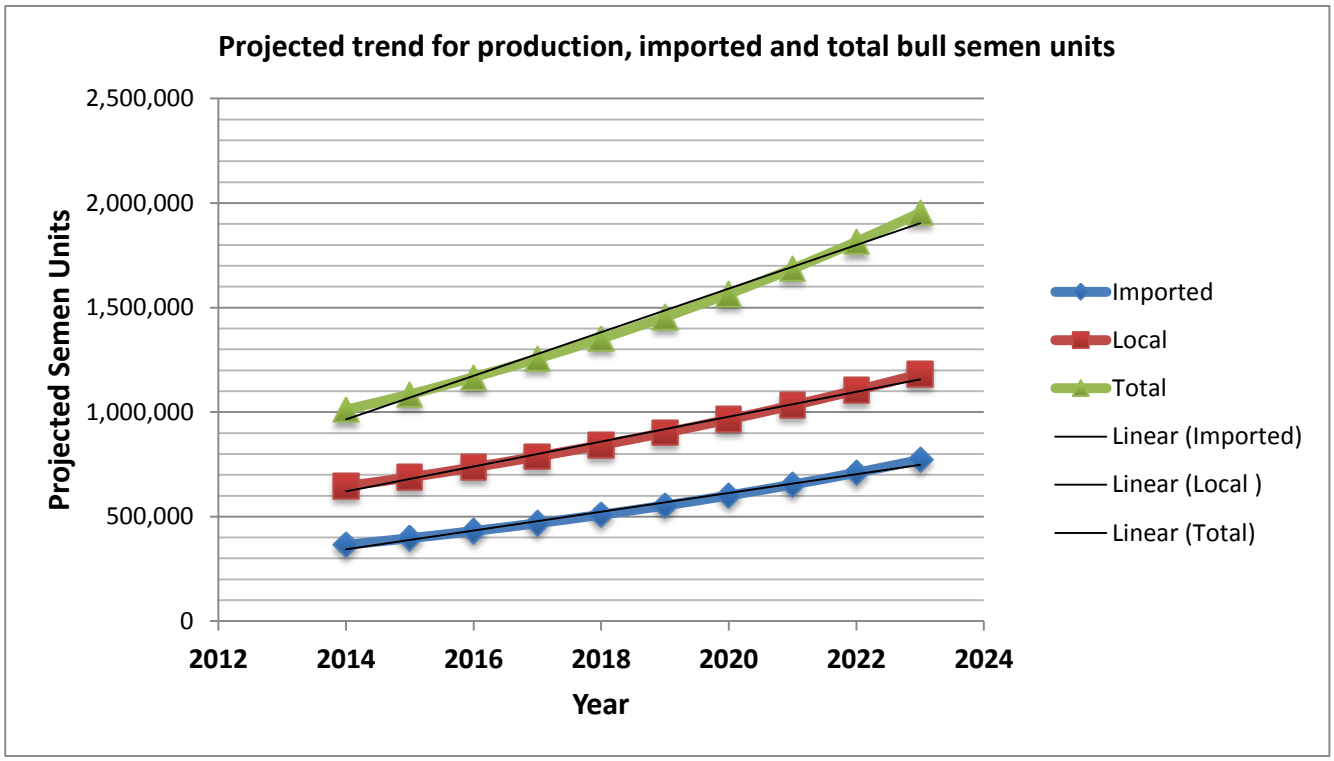

Figure 2: Projected trend for local production, imported and total bull semen units' demand from 2014 to 2023

3.1.4 AI services demand and delivery trends and projections for the next 10 years

As stated above, AI services are now being delivered by private sector players (Appendix 9). Since 2007, in the former Central and Rift Valley provinces KNAIS has now been completely replaced by private AISPs. Demand for AI services has also been increasing over the given years.

Despite the projected increase in AI services demand (Figure 3), data collected for the inseminations carried out from 2006 to 2013 does not account for semen produced locally and imports. The number of inseminations recorded average 30% of total available semen units suggesting that there is a challenge in getting returns for actual inseminations carried out. If this is the case, therefore about 70% of inseminations carried out are not being reported to the DVS office. If this estimation is correct therefore Kenya inseminations are likely to increase at an annual rate of 1.5% to 5%. Thus the number of inseminations will increase three-fold to over 2.3 million in 2023.

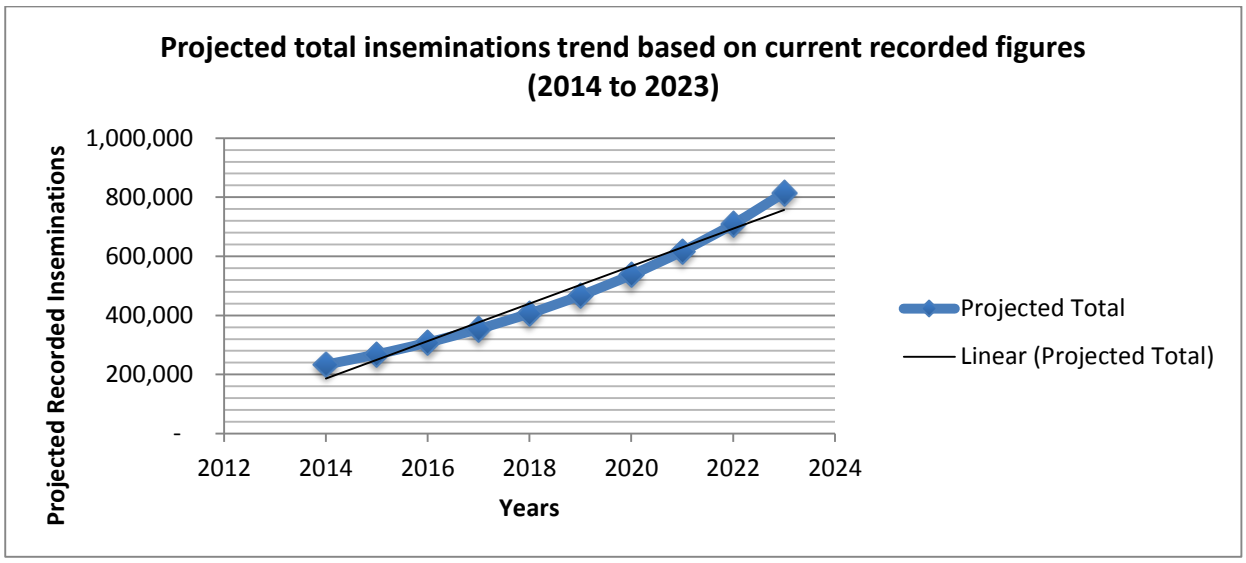

Figure 3: Projected total inseminations trend based on current recorded figures (2014 to 2023)

3.2 AI Value Chain

An AI service costs on average 950 to over 1,000 KES depending on semen used, local, imported conventional or imported sexed semen (Table 5). Imported semen prices range from KE 300 for conventional up to 7,000 for sexed semen doses. The key cost drivers for an AI service are bull semen, arm service and transport with percent shares of 43%, 37% and 14%, respectively (Table 5). The rest of the costs individually account for less than 3% of the total AI costs. The advent of devolution from provincial to county governance systems has resulted in differences in AI models and cost elements. Most counties including Bomet, Bungoma, Embu, Kakamega, Muranga, Machakos, Taita and Wote have resorted to AI subsidies, particularly for semen purchases. In Machakos and Wote counties, semen subsidies have resulted in increased uptake of AI technology with AISPs recording increased number of monthly services from 15 to over 50.

Table 5: AI Cost elements and % revenue share

#	Item/Description	Cost (Ksh)	% Share
1	Bull semen	400	43
2	Arms Service	350	37
3	Transport	127	14
4	Lubricant	29	3
5	Glove	10	1
6	Liquid nitrogen	8	1
7	Depreciation	7	1
8	Sheath	6	1
9	**Total**	**937**	**100**

While mark ups on semen prices along the value chain increase from KES 250 at distribution origin (agent) to KES 1,200 paid by the farmer, the farmers do not know the component that contributes to the large change in costs and pricing. The AISPs largely blame this cost increase on transport and liquid N costs; however, in our analysis the large cost increases emanate from bad business practices at the last mile AISPs' level. In this regard, AISPs charges are inconsistent and often based on farmer capacity to pay for the services.

3.2.1 Semen production and delivery to farmers

Bovine genetic supply in Kenya is by both public and private sectors (Figure 4). The local public sector bull station, KAGRC, has more than 100 dairy and beef bulls producing and distributing an average of 45,000 units of semen every month. Annual supply of bull semen from KAGRC stands at 650,000. As reported above, a second bull stud license has been given to ADC Kitale another parastatal hoping to commence production in 1 to 2 years. This will make local production a public sector business; however, there are reports that a private sector investor, Indicus Company, will establish a bull stud and engage in embryo business in partnership with a Brazilian Company.

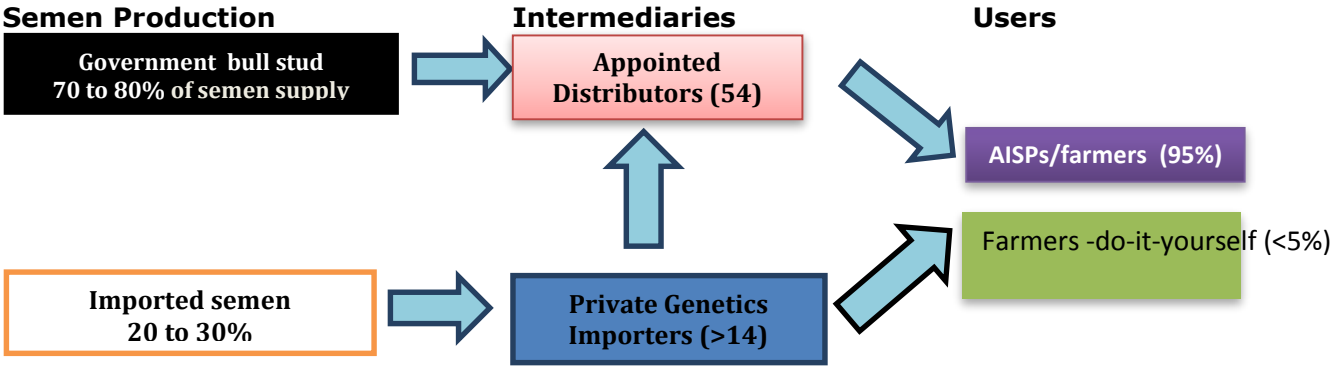

Figure 4: Semen production, distribution and delivery to AISPs and farmers

There are more than 14 private suppliers of dairy and beef semen including a few private commercial cattle farmer importers (Table 6). However, the consistent suppliers are only eight. All imported semen is through the DVS issued import permits and is subjected to DVS inspection. The inspection, among others, verifies imported units against permit allowed units and also determines post thaw semen motility/viability of randomly selected 2 to 4 semen units. Over 340,000 units of bull semen have been imported in the current year 2014, from several countries including Australia, Brazil, Canada, Denmark, France, Italy, Israel, Netherlands, New Zealand, South Africa, Spain, United Kingdom, and the United States of America.

KAGRC-produced bull semen is distributed through its 52 appointed distributors in most Counties in Kenya (Appendices 10 & 11). Private suppliers distribute either through the KAGRC distributors or independently and at times directly to AISPs, farmers and Agrovet shops that sell bull semen. From discussions at several recent meetings, it has been ascertained that KAGRC is in the process of changing its semen distribution model to eliminate distributors, and hence directly supply farmer groups and AISPs.

Table 6: Local Companies and the international genetics company they represent

No.	Local Company	Genetic Company
1	ABSTCM	ABS Global Inc. Genus
2	AI Total	Holland
3	Best Farm Genetics	Spain
4	Bimeda/Assia	Alta Genetics & Israel
5	Coopers Kenya Limited	CRV – Holland Genetics
6	DETF	Cogent
7	Fleckvieh	Fleckvieh Germany
8	Gogar	Vikings
9	Highchem	Cooperative Resources International
10	Indicus	Vikings and Evolution/Sersia
11	Pokea	Osnabrouk
12	Taurus	Taurus South Africa
13	Twiga Chemicals	Semex
14	World Wide Sires (East Africa)	World Wide Sires (Select Sires Genex)

3.2.2 Artificial insemination delivery models

The emergence of milk collection centres (MCCs) or commercial milk bulking enterprises has created hubs or AI services brokers for its members on a milk revenue based payment system. Under a strong competitive environment, the MCC has strong ties with its farmers and offers services directly or they are out-sourced to its members whereas under a weak competitive environment, the prevailing AI service provision model is the AISP providing AI service directly to farmers. Other models include farmers offering services to their neighbouring farmers. All models function well but the choice of which model to use depends on characteristics of the competitive environment and MCC/hub management dynamics.

3.2.3 Key value chain players and partners

The artificial insemination value chain players and partners in Kenya can be classified under demand side, supply side, public sector and other services. These include smallholder and commercial dairy farmers, dairy farmer cooperatives and self help groups, commercial milk bulking enterprises and MCCs on the demand side; and on the supply side, KAGRC (local semen production and distribution of semen and liquid nitrogen), private suppliers of breeding inputs (liquid nitrogen, bull semen, companion breeding supplies), breed associations and related organizations (Ayrshire, Boran Association, Guernsey, Holstein/Friesian and Jersey Associations), Kenya Livestock Breeders Organization (KLBO), LGSEA, East Africa Embryo Transfer Association (EASETA), Kenya Association of Livestock Technicians (KALT), Kenya Farmers Association (KFA), Kenya Dairy Farmers Federation (KDFF) and Kenya National Dairy Association of Producers (KENDAPO). Further, on the supply side there is the public sector including Ministry of Livestock Development (MLD) –DVS, Kenya Dairy Board (KDB) and KBS. Other services are provided by researchers including ILRI, Kenya Agricultural Research Institute (KARI) and TEGEMEO.

3.2.4 Supply of dairy genetics to Kenya

Domestic supply of genetic material

As stated above, KAGRC used to supply the bulk of dairy cattle genetic material in Kenya. This program was largely funded by the Department for International Development (DfID) under the Business Services Markets Development Program (BSMDP). Through this assistance, KAGRC developed a network of 52 agents and distributors. It obtains its dairy genetic material from over 100 domestically reared bulls and boasts that its dairy bull stud is made up of adapted exotic breeds.

The current semen production of 650,000 units consists of >95% frozen and <5% room temperature semen used in areas closer to the bull station (Appendix 12). This is distributed together with liquid nitrogen through the 52 appointed agents (Appendices 10 & 11). Most semen collected is from Friesian breed bulls followed by Ayrshire bulls (Table 7). Nearly 45% of the dairy breed bulls at KAGRC are six years and older. This is an infrequent bull recruitment frequency. The issues that arise from KAGRC operations include its inadequate dairy bull recruitment pool and bull breeding value evaluation system, and comparatively poor semen quality (Gamba, 2006). However, this situation could have changed since there have been management changes and infusion of new semen processing equipment purchased through the Worldbank funded East Africa Agriculture Productivity Project (EAAPP) grant.

Although Gamba (2006) reported that the system of establishing breeding values for KAGRC bulls was in transition from the old Contemporary Comparison Method (CCM) to the universally accepted Best Linear Unbiased Prediction (BLUP) method, the old system prevails and KAGRC still produces and distributes unproven genetics. The KAGRC does not have good performance data collection systems and supporting organizations are recording the performance of less than 5,000 cows (CAK AI Report, 2014) compared to 240,000 cows per bull in bull studs in developed countries.

Table 7. KAGRC Bull Semen Production by Breed

Breed	Production (%)
Friesian	65
Ayrshire	30
Guernsey	2
Jersey	2
Boran & Sahiwal	1

Source: Rhoteach, 2011: Technical Report to KDSCP-USAID

Genetic material imports

Genetic base diversification of locally produced semen requires the infusion of foreign genetic material to allow for the introduction of superior sires into the KAGRC bull pool. A KAGRC bull purchasing committee meets and selects top imported bull semen for use in breeding bull dams and recruitment of young bulls for the bull station. Dairy cattle semen constitutes the largest proportion of imported units in addition to small amounts of embryos (Figure 5). The major countries from which genetic material is imported are the USA, Canada, Netherlands, Spain and Denmark. Fewer semen units are also imported from Australia, New Zealand, South Africa, Israel and some parts of Europe.

To date, imported semen accounts for about 60% of the domestic genetics market and is distributed by over 10 major firms. The blend price for the distributed imported semen is usually below USD3.00 per unit.

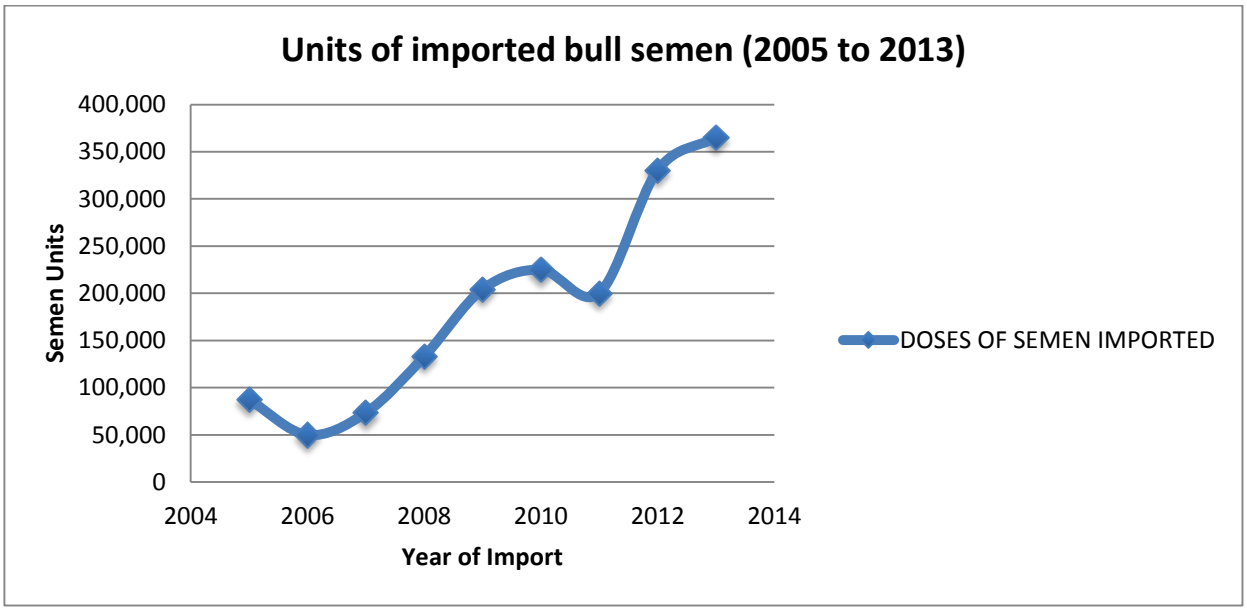

Figure 5: KAGRC imported bull semen doses from 2005 to 2013 (Source: KAGRC, 2014)

As shown in Figure 5, the units of semen imports from the foreign countries has been increasing exponentially from an average of about 50,000 units in 2006 to more than 350,000 units in 2013. This seems to be partly a response to the increased demand for milk, and hence the desire to increase milk production at farm level.

3.2.5 Semen procurement and distribution input suppliers

A key issue and input for the AI sub-sector is liquid N supply and distribution. Supply of liquid N is critical for expansion of AI delivery.

Liquid nitrogen supply and distribution chains

In Kenya there are three companies commercially producing liquid N and selling directly to the end users: British Oxygen Company (BOC), Welrods, and ABSTCM (Figure 6). They produce liquid N and store on the production site. Welrods and BOC have large industrial cryogenic distillation plants producing above 100 litres per hour and ABSTCM has a non-cryogenic plant. ABSTCM has stopped production of liquid N due to lack of business viability under direct competition from KAGRC-subsidized supply. Liquid N was also produced by KAGRC which owns a 40-liter per hour non-cryogenic plant. However, the latter plant is broken down beyond repair and KAGRC is in the process of acquiring a replacement plant funded by the World Bank under the EAAPP.

Other non-government small liquid N producers (5-10 litres/hour) producers include Center for Disease Control (CDC) in Kisumu, and the Walter Reed Program in Kericho County. It is important to note that the industrial production produces liquid N as a byproduct of oxygen and argon production and by far is the most competitive compared to the non-cryogenic plants (Figure 7).

Two private companies (ABSTCM and BOC) and KAGRC own bulk liquid N transportation trucks with capacities ranging from 400 to 5,000 litres. They supply liquid N directly to service providers, farmers and cooperatives on regular predetermined schedules and no contract is needed. Welrods and BOC are the largest producers that supply liquid N in bulk to KAGRC which then sells it to its agents. The agents in turn sell to the liquid N to the last mile farmers and service providers. The GoK-subsidized KAGRC does not fully recover the liquid N costs whereas private liquid N producers including ABSTCM recover full costs for up-country delivery. In addition, for the latter liquid N is produced to meet direct orders. Welrods produces for its on-site engineering works but also sells to customers from its production site in Nairobi industrial area.

The Kenyan liquid N supply system is sustained by:

- Involvement of private sector in production and distribution
- In addition to demand from industries, there is high demand for liquid N from the AI sub-sector that utilizes more than 18,000 litres per month. Annual liquid N sales revenue for the AI sub-sector alone is estimated to be greater than USD 648,000.
- Two companies, BOC and ABSTCM, used to offer cattle freeze branding services, which require 1.5 litres per cow.
- Companies such as BOC and Welrods have economies of scale because they produce liquid N and other industrial gases. Under this production system, liquid N is a byproduct eluting just before liquid oxygen and argon production.

The same Kenyan liquid N distribution model is constrained by:

- KAGRC is subsidized by the Government and does not charge full cost of service delivery thus distorting the market. Delivery to up-country agents is only done once a month, which is not enough for continued field AI service delivery. Though a pro-poor approach, this is not a growth model that is sustainable in the long run.
- Private sector and public sector competition in service delivery (3 companies) is supposed to ensure efficiency. However, currently this is not the case as deliveries are not coordinated and often there are periods when AISPs lack liquid N.
- Poor technical skills at the public-owned KAGRC bull stud, and previous use of defective liquid N refrigerators led to high flush and evaporative losses estimated to be greater than 30% (BSMDP Study, 2006). Furthermore, poor equipment calibration that resulted in working at high pressures increased liquid N losses. Costs arising from inefficiencies are passed on to farmers who in turn respond through low uptake of the AI services.

- Poor road infrastructure increases transaction costs and evaporative flush losses. Evaporative losses are estimated at greater than 35% at field level. Actual current average evaporative loss at KAGRC has now been reduced to 12% from 16% (KAGRC-personal communication).
- The factors determining the cost of liquid N are overheads for labour, production costs that are lower for cryogenic than non-cryogenic plants, demand period, electricity and transportation costs (Appendix 13).

Kenya liquid nitrogen model

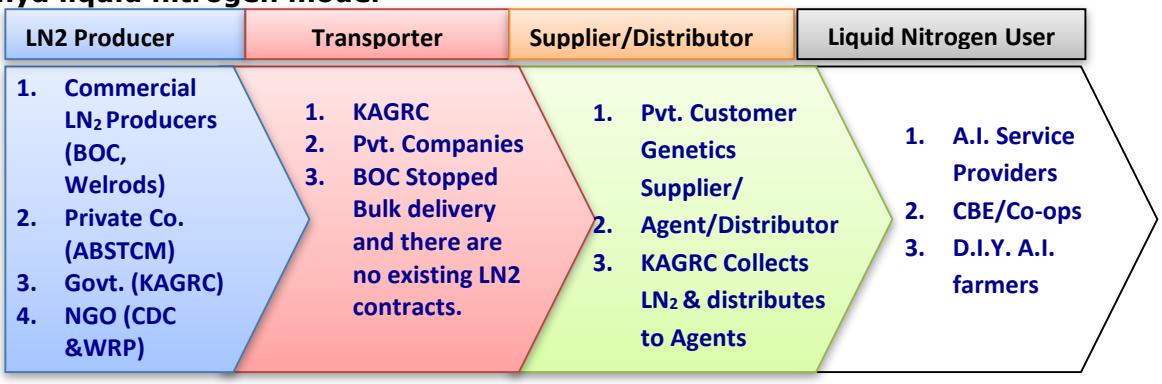

Figure 6: Schematic liquid nitrogen (LN2) value chain

Liquid nitrogen cost along delivery value chain costs

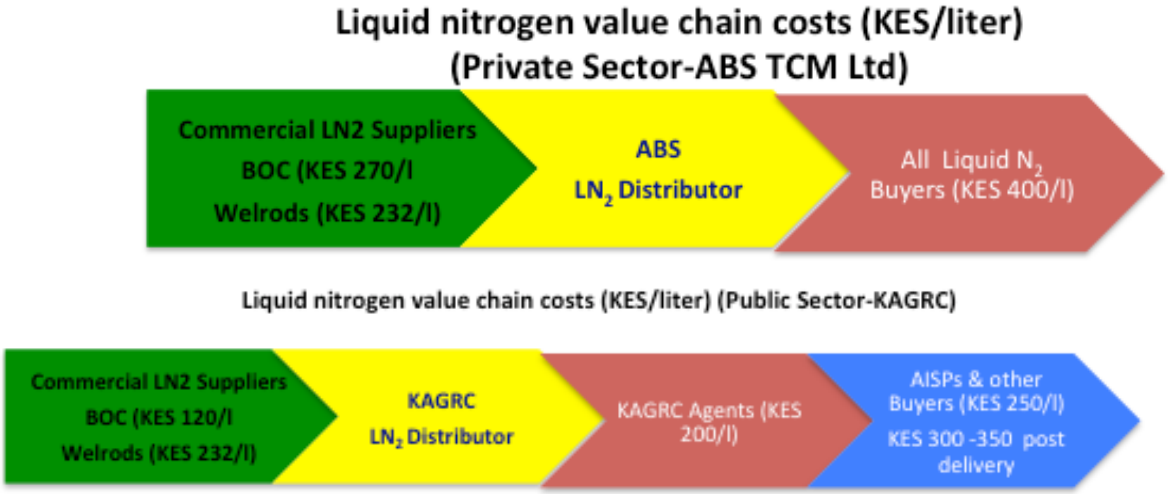

Figure 7: A comparison of private and public sector liquid N value chain costs

3.2.6 AI support services

AI support services are expected from public sector-led conducive policy frameworks, efficient suppliers of inputs (both public and private) and credit mechanisms. There remains room to improve such services. Starting from the bottom, service delivery improves with incentives.

Public sector

The DVS office offers services including processing of import permits, collection, and collation of AI service returns. Though at risk of market distortion, KAGRC services include semen and liquid N production and delivery services. Currently, there exists a conflict of interest when the DVS uses

KAGRC as its inspectorate for competitor semen imports as highlighted by the Competition Authority of Kenya (CAK AI Report 2014).

Private sector
Besides delivering semen, there are few private sector companies that directly offer AI support services to farmers, AI agents and semen distributors. ABSTCM used to offer a complete package of sales, installation and service until it realized that there was no customer loyalty. In fact, competitors would visit farmers supported by ABSTCM and offer lower prices for AI inputs. Regardless of product quality, the AI industry is price sensitive and the supplier offering the lowest price is the winner. Fully trained professionals who offer complete product support from AI planning to completion and a bundled service model are scarce.
The LGSEA is a newly formed society offering AI extension and self regulation of the AI industry players. In order to level out the AI industry playing field, a lot is expected from this society.

Microfinance
The AI industry players, particularly farmer cooperatives, commercial milk bulking enterprises and AI service providers usually require credit or loan facilities to enable them start their breeding businesses. Loans are needed to purchase AI equipment and supplies, means of transport, usually motorbikes, and operating capital. In Kenya, banks that have actively offered micro-loans include Equity, Family Bank, Fina Bank (now DTB Bank), and the Kenya Women Finance Trust and Cooperative Bank.

Insurance Companies
Recently, insurance companies in Kenya began offering cattle insurance to progressive farmers who adopt best farming practices that include AI use, cattle identification, vaccination schedules adoption, and milk recording. These companies include Jubilee Insurance Company of Kenya, UAP Insurance Limited, Takaful Insurance Company of Kenya, KWFT, and Blue Shield.

3.2.7 Models of private AI service provision

AI services are largely provided by the private sector with very little public sector service provision except in a few remote areas. There are three major models used under the predominant private AI service delivery, as follows:

- The first model is the "do it yourself" (DIY) which is largely practiced by commercial farmers who train and employ on-farm AI Technicians to inseminate their own cattle and at times those of neighbouring farms.
- The second model involves practising veterinarians and Agrovet shops that link AI service provision to their veterinary practices and/or farm input stores.
- The third model consists of milk bulking enterprise or co-operative run AI services that largely control their areas of operation due to patronage to the dairy co-operatives. The cooperatives attract membership through the provision of auxiliary services and milk revenue payment based systems. Delivery of AI services under this model can be one of the following:
    - Employed AI technicians run a motorized service in response to farmer calls.
    - Out-sourced, accredited AI technicians provide services to bona fide cooperative members.
    - Farmers give services to other farmers under what is termed "the village bull" system.

Njoroge et al. (2003), Gamba (2006) and the CAK AI Report (2014) suggest that the co-operative or hub model presents a viable option even for areas where private AI service provision appears to be faltering.

3.2.8 Training and knowledge transfer systems, extension services, and recording

Training of AI Technicians was liberalized and the syllabus harmonized by the GoK in 2006. Institutes or organizations proposing to commercially train AI technicians can apply for an operating licence from the DVS. Specifically, the requirements are that such organizations apply to the DVS, have their premises inspected, use a DVS-prescribed AI training syllabus, and recruit candidates with minimum

Ordinary Level qualification, a diploma or degree in animal health or animal science (see Appendix 14 for details). However, a Bachelor of Veterinary Medicine holder does not require an AI practice certificate. The duration of training is 6 weeks.

Institutes and companies currently offering AI technician training include ABSTCM, Animal Health Industry and Training Institutes (AHITI), Dairy Training Institute (DTI), University of Nairobi, and the Agricultural Development Corporation (ADC).

3.2.9 AI sub-sector institutions, associations, forums, governance and policies

AI subsector institutions include the DVS, AHITI, LGSEA, KLBO and KAGRC (Figure 8). Unfortunately, Kenya has no written breeding policy to guide breeding investments and activities. Previously, all AI regulations and control were under the public sector but with the advent of private sector organizations, particularly LGSEA and KLBO, there is now interaction between the private and public sector in supporting and controlling the AI sub-sector.

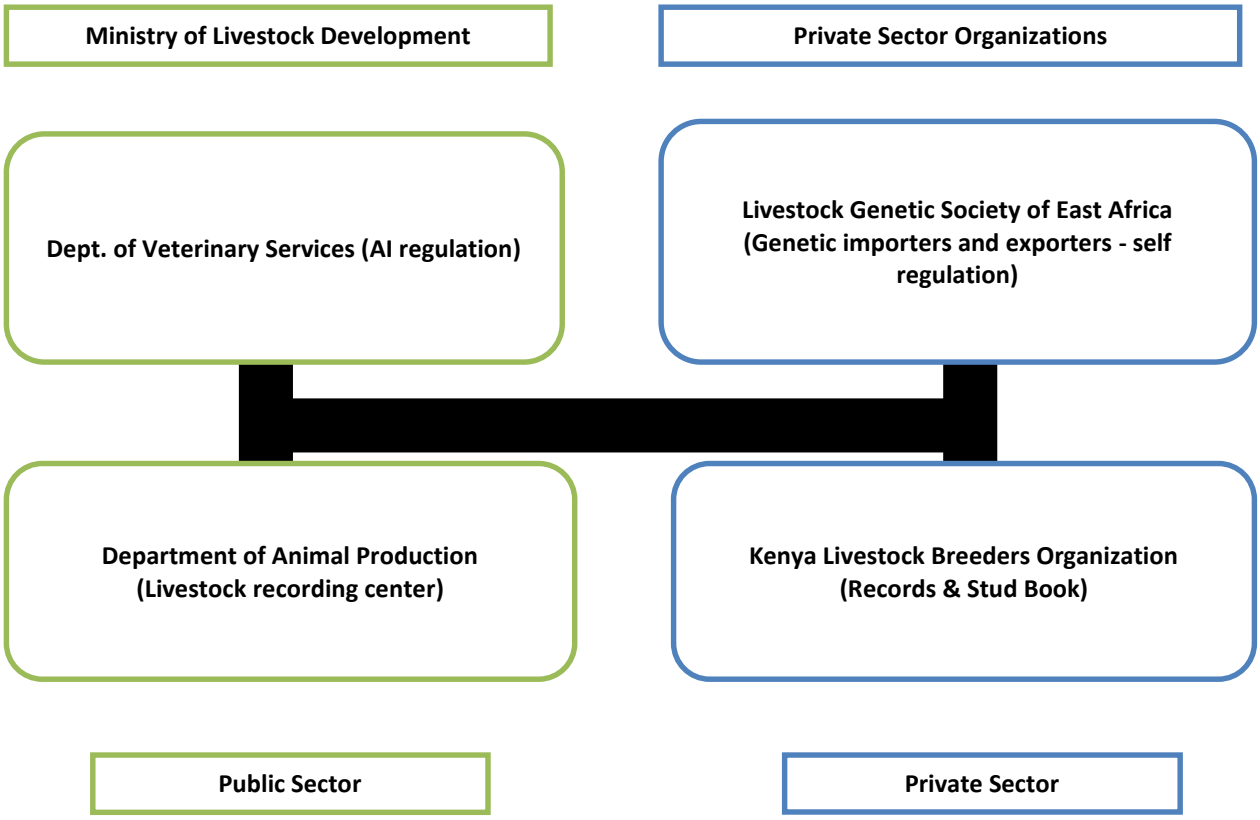

Figure 8: Emerging public-private AI sub-sector model

The AI sub-sector associations are largely the National AI players (local KAGRC and importers of genetics) in the livestock genetic supply chain. The LGSEA is a key new association that is expected to self-regulate the industry. The membership of LGSEA consists of importers and producers of livestock genetics nationally, livestock genetics distribution agents, and AI practitioners operating across the counties. The society membership has categories of membership that include corporate, livestock genetic agents, individuals, affiliates and associates.

Besides being the industry self-regulation player other objectives of the LGSEA are to:

- Facilitate access to quality livestock genetics and service delivery throughout the Eastern Africa Region.
- Promote industry best practice by providing certification, collating of data, reporting and monitoring services.
- Build strategic partnership and alliances to foster industry growth and development.

- Lobby and advise on policy for the overall benefit of the industry.

Apart from LGSEA is the KLBO which is a farmers' organization formed under the auspices of the Agricultural Society of Kenya to promote and coordinate livestock breeding in Kenya. Its main objectives are to:

- Facilitate livestock information flow for enhanced decision-making capacity in selection, breeding and livestock management.
- Provide a forum for exchange of ideas and training of livestock producers and stakeholders in the livestock industry.
- Champion the interest of livestock breeders in all facets of livestock improvement.

The three main KLBO functions are:

- Livestock registration through the Kenya Stud Book (initially called East Africa Stud Book which was started in 1921 and was responsible for keeping a pedigree register of livestock in East Africa) and maintenance of a central database for all registered stock.
- Performance recording (taken over from the former Kenya Milk Records formed in 1970 and managed by the government under the Kenya Dairy Board) where the data collected on production becomes an important basis for selection on-farm. The performance data is availed to the KAGRC bull purchasing committee and the Livestock Recording Center under the Ministry, Department of Livestock and Fisheries.
- Provide extension services to empower farmers with the necessary skills for livestock husbandry.

The KLBO has not been effective because it has limited funding and manpower capacity to achieve its goals. Currently, it is registering less than 6,000 dairy cattle and has no robust performance recording programs. There is concern that KLBO responsibilities will be duplicated by the Dairy Centre of Excellence program funded by EAAPP.

3.2.10 Value chain and asset financing including credit facilities for farmers and suppliers

There are several banks and microfinance institutes lending to AI value chain players. Lending is mainly to farmers, farmer groups, and AISPs to purchase AI equipment, motorbikes and breeding cattle. The main lending institutes and banks include the Kenya Livestock Finance Trust, Family Bank, GTB Bank (former Fina Bank), Equity Bank, Kenya Women Finance Trust, Cooperative Bank and Kenya Commercial Bank.

The loans are short term and usually the value does not exceed KES 400,000 (USD 4,500) which suffices for purchase of most AI equipment (Appendix 15). For example, a fully loaded AI kit that includes a 3-litre field liquid N tank costs KES 52,575 (USD 591), and a semen and liquid nitrogen storage 35-litre tank costs KES 65,500 (USD 735). A bred heifer average cost ranges from KES120,000 (USD 1,348) to KES 200,000 (USD 2,247). Motorbikes are the common means of transport for AISPs and the cost plus annual insurance are in the range KES 140,000 (USD 1,404) to KES 336,000 (USD 3,370).

3.2.11 Access to good quality and reasonably priced equipment

Major suppliers of good quality and reasonably priced AI equipment and companion supplies include the public sector, largely KAGRC, and private sector including ABSTCM and Medlink Ltd. The main products include AI liquid N tanks that range in size from 1 litre to 50 litres, semen thawing goblets, thaw thermometers, plastic goblets for liquid N tank canisters, cryo-claws, low level liquid N warning devices, carbocil material, temperature thaw monitor ampules (only from ABSTCM), universal pistolletes, cito cutters, semen forceps, sheaths, gloves, and ear tags with taggers/applicators and lubricant.

Only ABSTCM provides service on testing, repair of liquid N tanks and training on care and maintenance of AI equipment. Chart Industries/Minnesota Valley Engineering (MVE) largely supplies liquid N tanks from its production facility in Asia, and most suppliers are also sourcing from other Chinese companies

producing the YDS liquid N tank series. Other tank suppliers are Taylor Wharton and Air Liquide, and the Indian companies BA, and INOXCVA.

These items are distributed to farmers, cooperatives, Agrovet shops and milk bulking enterprises by direct orders, and through KAGRC and private sector distributors and their outlets. Items are regularly available and the business is now largely in the hands of the private sector.

3.2.12 General challenges, constraints, policies and regulatory framework impacting on AI value chain

Kenya maintains an open market policy for genetic imports and has largely depended on importation of such imports to improve its local livestock breeds. In this regard, any registered company or organization can import genetic products as long as the import permit requirements are met and import inspection channels are followed. The general challenges, constraints, policies and regulatory framework impacting the AI value chain have recently been reviewed and documented (CAK AI Report, 2014). These include the following:

- One of the major challenges facing the AI industry is partial instead of full privatization of AI services that began in 1993 which has retarded growth and delivery of private sector services. The state-controlled KAGRC operates in direct conflict with private sector and, until recently, was supplying up to 80% of bovine semen to farmers and delivering as much as 95% of required liquid N to countrywide KAGRC agents (Appendix 4). Contrary to expectations consistent with privatization of the AI industry, a second public sector bull stud has been licenced to start production in the next one to two years and will be operated by ADC Kitale making it and KAGRC the only semen producers. The private sector faces tough competition against such government subsidized institutions and services. For example, some private players (e.g., ABSTCM) had invested in liquid nitrogen plants, distribution vessels and trucks that had to be decommissioned in the face of unfair competition from the state-funded and subsidized services.
- KAGRC bull semen production is inefficient. Semen production stands at 8,200 units per bull/year compared to international bull studs which produce above 100,000 units per bull/year. Despite this gross under-production, as stated above another parastatal, ADC Kitale, has been given a license to operate a second bull stud. Surprisingly, the KAGRC Chief Executive Officer reported that KAGRC is currently meeting local demand for bull semen.
- Apart from continued investments in on-site liquid N generators distorting the market for liquid N distribution by the private sector, the public sector continues to ignore the challenges in managing on-site liquid N generators. Recently, the KAGRC Chief Executive Officer reported that KAGRC will be installing six more liquid nitrogen plants (on-site liquid nitrogen generators). The six plants will be installed at the following locations: KAGRC main AI station (replace a broken down plant), Eldoret Town, Meru, Nyahururu, Sotik, and Voi. Historically none of the on-site generators have operated for more than two years due to poor after-sales service and lack of capacity to maintain them. Furthermore, there is limited knowledge on handling, transportation and liquid N use. The cost of inefficient liquid N handling is currently passed on to farmers resulting in high liquid N prices.
- The DVS has the mandate to regulate semen imports into the country by issuing zoo-sanitary import permits and inspecting the semen for quality assurance at importation before releasing it to importers. Regrettably, the DVS has hitherto delegated this inspection and testing for semen quality to KAGRC thus creating conflict of interest since private importers are in direct competition with KAGRC. As a result, some importers have suffered from unfair decisions, and hence incurred uncompensated semen losses ostensibly through KAGRC's biased decisions. However, since the DVS office capacity has been improved under the EAAPP program, equipment is now available for the DVS office to independently inspect semen imports.
- Imported genetic material including semen is further subject to taxation and levies. The taxes and levies are the Railway levy (1.5% of import value), GoK fees (3% of import value), KES 20 per unit imported, Kenya Airport Authority fees, and clearing agent fees based on value of consignment. These taxes and levies are not applied to locally produced semen. Furthermore, locally produced semen is not subject to similar stringent quality standards applied to imported semen making the playing field uneven for private sector competition. Also, the semen import permit requirements

include some that are non-zoo-sanitary contrary to the Organization International Epizootics (OIE) prescriptions for semen imports that are just zoo-sanitary. An example of a current non-zoo-sanitary semen import permit requirement is that semen should be from bulls free of recessive genes, and the bulls should have positive genetic proofs. There is therefore a need to harmonize semen import permit requirements to OIE or international certified semen standards. Also, in order to level the playing field, the GoK should equate the requirements for semen imports to those for locally produced semen. A good example of such policy is in Iran where semen produced at local bull studs has to meet international standards.

- National and transboundary disease control remains a key challenge for DVS; for example, there is high disease prevalence including brucellosis and Rift Valley fever (RVF), particularly in the Transmara region.
- The Department of Livestock production is in charge of the national breeding policy; however, the final breeding policy developed that was submitted to the Parliament of Kenya has still not been promulgated.
- The Kenya Bureau of Standards (KEBS) regulates the semen sub-sector through the Instrument KS ISO 8607:2003; however, this instrument requires some amendments.
- Regulation of the AI sub-sector under the devolved county system remains unclear. Specifically, the advent of counties has clouded the way forward on the AI and liquid N supply regulatory framework. Some counties including Embu, Bomet, Machakos, Murang'a, Kakamega and Taita have introduced subsidies on artificial breeding that have distorted privatized AI delivery. The AISPs in Murang'a County have already gone to the law courts to challenge the subsidies. In addition, some AISPs, for example in Murwaki area of Nyandarua, are now unofficially zoning individual areas of operation. However, currently, it is generally understood that in this devolved governance system the national government is responsible for policy and standards formulation, and semen quality assurance while the counties are in charge of service provision. However, the national DVS is still obliged to advise counties on all issues in the AI sub-sector.
- The Public Private Partnership Act of Parliament (www.kenyalaw.org) encourages public-private partnerships and provides guidelines to achieve government and private sector partnership models.
- Farmers do not have adequate knowledge on prudent breeding which is exacerbated by poor and uncoordinated farmer training, weak breed associations, lack of functional performance recording, bad business practices, inconsistent recording of inseminations by AI service providers, low fiscal funding resulting in a weak regulations enforcement, and lack of mandatory AI service provider refresher training for quality service delivery. The LGSEA was formed with a partial goal of self-regulation; however, this has not been fully realized. The majority of AISPs are operating unlicensed and farmers or consumers of AI services cannot distinguish accredited or licensed from non-accredited or unlicensed AISPs, respectively.
- As a result of low farmer education, the benefits of using proven genetics are not appreciated; consequently, farmers tend to buy or use the lowest priced semen. Most farmers therefore renege to purchasing the mass marketed unproven locally produced bovine semen and products. Another challenge for the private sector, which largely distributes proven semen backed by records, is the lack of product differentiation with the locally produced semen in relation to bull breeding value. This failure to discern imported and locally produced semen quality differences negatively impacts product pricing and affects price points.
- Bad business practices include overcharging, lack of transparency on imported compared to local semen with AISPs refusing to divulge semen straw identification details. Farmers are ignorant about differences in imported and local bulls breeding values and AISPs do not encourage use of sire directories as most do not understand how to use them. Thus, farmers rarely select prefered bulls or semen to be used for their cows, rather, they remain dependent on AISP's choice or whatever is available.

3.3 Financial Analysis of the AI Value Chain

In our inception report we proposed to undertake full investment, monthly and annual operating costs, monthly and annual revenues, breakeven and internal rate of return, and investment risk analysis for bull stud establishment for semen production, and semen distribution and AI service provision.

However, we realize that this information may not be useful and relevant and is dependent on selected investment strategies that are relevant to the business environment.

3.3.1 Bull stud for semen production

Several business models are possible for semen production (bull stud) and distribution opportunities. These include the following:

- Only when existing Parastatals operate on full business models free from subsides or government interference then strategic partnership with an existing bull stud to offer technical and management capacity and share profits can be explored. An example is what CRV/Holland Genetics is already doing providing genomics capacity to the KAGRC. This strategy also allows the foreign investor to understand the market and perceived business risks.
- Production of bull embryos from home country breeding facilities and transplanting in Kenya to produce bull stud bulls of known pedigrees/parentage and superior genetic merit. The local breeding values can then be determined through investments in performance recording and genomic studies. This also allows production of bulls that suit the environment such as synthetics breeds made with *Bos indicus* and *Bos taurus* crosses of various levels, for example the Girolando (3/8 Gyr x 5/8 Holstein)
- Semen warehousing and distribution business where the investor imports competitively priced bovine genetic products including bull semen and embryos demanded by the market.

Other factors that determine the appropriate investment model include land price that depends on areas of bull station location, and costs of fencing to ensure bio-security, buildings for bull barns, semen collection unit, administration, laboratories, packing and warehousing facilities. Investments will also include equipment including liquid nitrogen transportation and storage containers, semen freezing and packaging equipment, microscopes, laboratory equipment, staff protection gear, semen collection equipment, vacuum tunnels from collection unit to laboratory, labeling equipment, vehicles, IT equipment and stationery. Funds will be required to set up and manage an efficient distribution network and for a performance recording program to determine breeding values. All costs will be determined by an investor's choice of equipment, equipment sophistication as per latest technologies etc. This therefore makes it difficult to compute generic cost estimates.

3.3.2 Semen distribution and AI service provision

Semen distribution and AI service provision success determines the market for the AI business. Financial analysis of the semen distribution and AI service provision reveals that artificial insemination using ordinary semen has the highest internal rate of return (IRR); however, net present value (NPV) is higher where sexed semen is used (Table 8). It is clear that AI can derive benefits and good investment returns.

Table 8: Financial analysis variables for bull and artificial insemination (AI) services

Financial Variable	Bull Service	AI Using Ordinary Semen	AI Using Sexed Semen
Total cost benefit to farmer – KES	6,211	21,241	37,835
Total cost – KES	421	857	9,333
NPV – KES	15,120	52,240	53,686
IRR – %	115	131	61

This implies that investment in the semen distribution business will be adequately supported by viable AI business. The operating costs and net income from a typical AI service provider are in Appendix 16.

3.4 General Analysis of Investment Opportunities in the AI Value Chain

In our inception report, we conceptualized that a growing dairy cattle population creates an opportunity for a sustainable or viable AI business that should produce or provide genetic material which matches the environment, ensures continuous production improvement, and inspires farmer loyalty and knowledge acquisition. In addition, where bull studs are established AI business is likely viable when there is a market for not less than 3 million semen doses and should be invariably supported by strong independent breed associations that pursue the grail of archiving verifiable, authentic breeding performance data. Clearly, from this study there is evidence of growth in the AI business that is consistent with cattle herd growth. The AI sub-sector is improving with new institutions having been created to support and regulate the AI sub-sector. However, of concern is the limited farmer knowledge on, among others, semen product quality and bull breeding values. With regard to establishing bull studs, there is little evidence that the current semen demand justifies such investment. However, as will be discussed below, partnerships with local bull studs could be the interim investment option.

There are several investment opportunities including those in local manufacture of AI consumables, semen production and financing AI business (Table 9). The current value of AI sub sector business minus breeding industry data business is estimated at USD11.3 million at 18% of dairy herd AI usage but at 60% of dairy herd AI usage the potential would be USD 37.6 million.

Table 9: Value chain segments with investment opportunities and their current (18% AI use in dairy herd) and potential (60% AI use in dairy herd) business value

Value Chain Meta Institute	Investment Opportunity	Current Business Value (USD)	Potential Business Value (USD)
Companion breeding inputs: sheaths, gloves, lubricants, cito cutters, forceps, thawing flasks, thermometers, liquid N dipsticks, pistollettes, heat synchronization drugs	Importation and warehousing or Local manufacture & distribution in Kenya	994,444	3,823,950
Liquid nitrogen	Country wide infrastructure	602,446	2,000,000
Semen production	Production of local based synthetic dairy breeds bull semen and embryos	3,888,889	12,962,963
Semen distribution	Importation and distribution of appropriate semen products and embryos	1,361,111	6,222,222
AI service provision	Professional delivery of AI services and extension	4,444,444	14,814,815
Breeding industry data	Collection and collation of dairy production records and parentage for performance assessments		
Finance & Credit	Microfinance to service providers and farmer groups	3,075,556	13,669,136
TOTAL VALUE		**11,291,334**	**53,493,086**

Investment opportunities in the AI and VP for the Dutch private sector will be presented in Chapter 4.

CHAPTER 4: CURRENT STATE OF VACCINE PRODUCTION (VP) SUB-SECTOR

The availability of veterinary vaccines is a necessary condition for a healthy and productive livestock population. In addition, if disease free zones are created, there is potential to create market opportunities for the export of livestock and livestock products, particularly to the Middle East countries as previously experienced.
Estimates of the burden of key veterinary diseases prevalent in Kenya are as follows:

- East Coast Fever (ECF) is the most important livestock disease in Africa. Losses in East Africa exceed USD 300 million per year, killing 1 million cattle per year.
- Contagious bovine pleuropneumonia (CBPP) is a prominent cattle disease in Africa. Losses in East Africa amount to around USD 60 million per year.
- Rift Valley fever (RVF) is endemic to Kenya and able to infect humans. An outbreak in 2006/7 in Kenya cost around USD 30 million and caused 140 human deaths. Outbreaks can be prevented by a sustained programme of animal vaccination and sustainable mitigation plans such as GIS mapping and rainfall or precipitation scoping.
- Foot and mouth disease (FMD) is endemic in most parts of Kenya resulting in regular outbreaks.
- Brucellosis, endemic in Africa, can be transmitted to cows through bull service. It also affects humans through consumption of milk from infected cows. It is prevalent in the Masai zones of Narok, lower Bomet County and Transmara region.

Since the trade liberalization period of the mid-1990s, public intervention has focused on surveillance and prevention of notifiable diseases. In Kenya, the notifiable diseases include anthrax, CBPP, ECF, FMD, heartwater, lumpy skin disease, Newcastle disease, rabies, Rift Valley fever and rinderpest. Clinical services have been left almost entirely to the private sector; however, with little attempt to support or coordinate the privatization process. As a consequence, privatization of veterinary health services has been generally slow and patchy, particularly in areas with low concentrations of dairy cattle. The provision of vaccinations was at peak before the 1990s (Appendix 17). The number of doses distributed was up to 35 million in 1987.
Non-notifiable diseases that are also important include worm infestation, reproductive disorders, mastitis, scours and some tick-borne diseases. It is clear that even if private sector can play a role, public-good disease control interventions, such as vaccinations, should be supported by government veterinary services and public resources. Clinical services in intensive high-potential areas can be given by the private sector. However, reliable access to clinic veterinary services is problematic and variable for different types of dairy producers. Only about 100 to 150 veterinarians are in private practice and the majority of animal health services and veterinary products are provided by the informal sector through shops known as agrovets. Up to 30% of farmers have no access at all to veterinary services.

4.1 Vaccine Production Statistics

4.1.1 Statistics on livestock species and populations with potential to use vaccines

In Kenya, vaccines are largely required for disease control in cattle (beef and dairy), goats, sheep, pigs and poultry. However, there is a limited demand for companion animal vaccines such as parvo-virus and rabies vaccines for dogs. While it has not been easy to establish the doses for each species that have been sold, the large populations of the key animals, cattle, goats, sheep, pigs and poultry suggest a high potential demand for vaccines (Table 2 above).

4.1.2 Demand and supply of local and imported vaccines for important livestock species over the last and next 10 years

A repository for national vaccine transactions is absent; as a consequence, the current real demand for vaccines is difficult to firmly establish. Specifically, the absence of reliable national statistics on

vaccines traded or supplied on the market is a major weakness that requires action by the responsible government agencies. The absence of such information creates a risk for potential investors in the value chain.

However, vaccine supply statistics for up to the beginning of the 1990s indicate a potential demand that is unmet (Appendix 17). In this study, the real demand was estimated from national livestock offices but it is becoming difficult to get current statistics due to the devolution of services to county level. In addition, there has been no recent livestock census to get an idea of livestock populations.

Despite this, from interviews with KEVEVAPI and the DVS the increasing demand for vaccines over the last 10 years was confirmed. The recent statistics on KEVEVAPI vaccine sales (Table 10) demonstrates an increase in vaccine demand compared to the last records in the late 1990s (Appendix 17) when vaccine supply was privatized. In the 1990s, vaccine supplies per year averaged less than 8 million doses. In 2013/14, KEVEVAPI vaccine sales reached 27.6 million doses worth almost USD 3 million. The resurgence in demand for vaccines has been partly from substantial orders coming from county governments (34%) and the export markets (19%). While it was difficult to estimate vaccine quantities imported by the private sector, according to the ToR in 2013 Kenya imported veterinary vaccines valued at USD10 million. The estimated value of distribution services is about 300 million KES. According to KEVEVAPI, in 2013 the GoK spent 130 million KES on veterinary vaccine purchases.

Supply of vaccines, except for some poultry diseases, is largely from the Kenya Veterinary Vaccine Production Institute (KEVEVAPI) and private companies and suppliers. However, because of trade secrecy, it has been difficult to establish vaccine doses supplied by private companies. Important vaccines are those for control of FMD, CBPP, Rift Valley fever, ECF, NCD and Gumboro.

In the absence of a repository of vaccine demand and supply data, it is difficult to track the demand and supply in the last and next 10 years. However, the livestock populations have been increasing over time, and hence a commensurate increase in vaccine demand and supply is expected.

Some vaccines including those for foot and mouth disease and rabies are expensive and in 2013 cost 44 and 60 KES per dose.

KEVEVAPI claimed that it is meeting the demand for vaccines in Kenya, but not for all types, particularly poultry vaccines. It anticipates an increase in demand for vaccines during the next 10 years. The counties are likely to create the largest demand in their quest to eradicate major diseases such as PPR and FMD. Increased demand is anticipated for FMD, PPR and contagious bovine pleuropneumonia (CBPP) vaccines. However, in the past the demand for vaccines has not been predictable and was largely driven by disease outbreaks.

Table 10: KEVEVAPI Vaccine sales in 2013/14

Vaccine	**Disease Controlled**	**Doses Distributed**				**Unit Retail KES Price/dose 2013**	**Total Sales KES**
		County Govts	**Local Buyers**	**Export**	**Total**		
LUMPIVAX	Lumpy skin disease	420,900	695,000	330,000	1,445,900	9	13,013,100
AVIVAX-F	Newcastle disease	10,000	748,700	-	758,700	1.5	1,138,050
AVIVAX I2	Newcastle disease	-	425,500	-	425,500	1.5	638,250
AVIVAX-L	Newcastle disease	87,000	495,150	-	582,150	1.5	873,225
POXVAX	Fowl pox	-	18,900	-	18,900	5	94,500
TURKEYVAX	Turkey pox	-	1,100	-	1,100	6	6,600
RIFTVAX	Rift Valley fever	125,000	18,700	3,689,000	3,832,700	12	45,992,400
BLUEVAX	Blue tongue	40,000	16,800	-	556,800	12	6,681,600
S&G VAX	Sheep $ goat pox	1,222,500	1,206,000	-	2,428,500	7	16,999,500
ORFVAX	Contagious pustular dermatitis (orf)	20,000	7,000	-	27,000	12	324,000
PESTEVAX	PPR disease	3,785,300	447,800	85,000	4,318,100	6	25,908,600
CAPRIVAX	Contagious caprine pleuropneumonia	1,685,600	2,229,800	29,700	3,945,100	12	47,341,200
CONTAVAX	Contagious bovine pleuropneumonia	342,500	657,700	15,000	1,015,000	6	6,090,000
FOWLPOX	Fowl typhoid	760,000	4,302,300	935,000	5,997,300	3	17,991,900
FMD-MONO 'O'	Foot & mouth disease (FMD)	20,800	26,000	80,000	126,800	11.5	1,458,200
FMD-MONO SAT 1	FMD	43,000	65,000	-	108,000	11.5?	1,242,000
FMD-TRI	FMD	410,000	770,000	-	1,180,000	31	36,580,000
FMD-QUAD	FMD	490,000	257,000	45,000	792,000	44	34,848,000
Total		**9,462,600**	**12,338,450**	**5,208,700**	**27,559,550**		**257,221,125**

It seems the vaccine production from KEVEVAPI was lower than the demand prior to the 1990s. KEVEVAPI supplied between 1.1 and 2.1 million blended foot and mouth disease vaccine doses from 2010 to 2013 (Table 10). In general, while the 2013/14 figures are substantially higher than during the 1990s, the demand for vaccines does not seem to show a trend and it is likely blurred by disease outbreaks and incidence in particular years. KEVEVAPI confirmed the unpredictable demand for vaccines but, as stated before, confirmed projected increasing demand for the next 10 years. Of interest has been the increasing number of KEVEVAPI regional foot and mouth vaccine customers that include Burundi, Rwanda, Somalia, Uganda and lately the Democratic Republic of Congo. It is likely that some of these customers coming to KEVEVAPI are buying vaccines to deal with disease outbreaks.

KEVEVAPI has not been able to meet the regional vaccine demand. In general, while this is outside the scope of this study, a vaccine demand (market) study in the regional markets would be important to establish the real demand and the types of vaccines in demand.

In Kenya, the counties started buying foot and mouth vaccines in 2013 (Table 11). The purchases from the DVS drastically decreased. As shown in Table 9, vaccine sales to the counties and local sales that include private purchases are increasing. In descending order of importance, vaccines for the following diseases were considered to be the most important: FMD, ECF, brucellosis, lumpy skin disease, anthrax and RVF.

4.1.3 Vaccination services demand and supply

The envisaged vaccination services include the delivery, storage and administration of vaccines, follow-up services after vaccinations, and relevant extension services. Delivery of vaccines is done by government veterinary agents for control of outbreaks and key diseases including notifiable diseases. Private veterinarians can also deliver vaccines to farmers but farmers have to individually source some vaccines. In general, vaccine distribution is not a stand-alone activity but is embedded in the delivery of veterinary services. As a result, in order to increase demand for veterinary vaccines the animal health extension services should be improved. This is currently an area of concern; in addition, the cold chain is insufficiently developed for vaccine storage. Development of requisite infrastructure for vaccine distribution largely requires public sector support. Private companies that produce vaccines could assist by providing requisite storage equipment at wholesale rather than retail level.

From interviews it was clear that, overall, since the advent of privatization in the 1990s, vaccine sales through vets and paravets have increased suggesting a strengthening of private sector involvement. In general, KEVEVAPI distributes its vaccines through agrovets, county veterinary officers and NGOs. Most vaccines supplied by KEVEVAPI are procured by national and county governments in Kenya and this same distribution system would apply at county level.

4.2 Vaccine Production Value Chain

Currently KEVEVAPI locally produces vaccines and sells directly to users and stockists. As reported above, imported vaccines, mostly for poultry, are supplied through agents/distributors that then sell to farmers. In general, the value chain has the main vaccine producer KEVEVAPI and private sector importers which supply vaccines directly to farmers, or through farmer groups including MCCs, government departments that then reach the farms. As noted above, vaccines are now being supplied to some counties but it is not clear how these vaccines are distributed.

Table 11: KEVEVAPI blended foot and mouth disease vaccine doses (x1000) supplied to Kenyan and regional customers from 2010 to 2013

Year	Customers													Total
	Burundi	DR Congo	DVO KAJIADO	Ethiopia	[1]Kenya (K) C. Gov.	K Counties	[2]KDVS	[3]KEVEVAPI (R&D)	[4]KLS	Rwanda	Somalia	Sudan	Uganda	
2010	-	-	-	-	-	-	200	-	40	130	60	-	-	430
2011	-	-	70	100	-	-	922	-	220	-	90	-	518	1,920
2012	70	-	-	70	-	-	766	1.2	92	150	110	55	366	1,680.2
2013	50	620	-	-	40	130	15	-	500	-	76	111	550	2,092

[1]Kenya Central Government; [2]KDVS – Kenya Department of Veterinary Services; [3]KEVEVAPI – Kenya Veterinary Vaccines Production Unit (Research & Development); [4]KLS – Kenya Local Sales. Source: KEVEVAPI

The VP value chain includes suppliers of inputs for vaccine production including for supply of eggs, liquid nitrogen for the cold chain, and service providers for vaccine administration.

4.2.1 SWOT analysis

It is apparent that, among others, there is a large market for vaccines, particularly in the poultry sector that is growing rapidly (Table 12). The GoK regulations on vaccine production and supply seem reasonable and are not an impediment to the establishment of the vaccine production and supply business. While anecdotal, opportunities for supply of vaccines to regional markets seem buoyant. The major weaknesses in the vaccine industry include the market distortion from KEVEVAPI, the GoK subsidized organization that, in general, sells vaccines at subsidized prices. In addition, quality control and information systems stewardship are inadequate. Such weaknesses, particularly poor quality control, make way for threats from external vaccine suppliers that have better quality and cheaper products. An inherent weakness cited by respondents is the difficulty in predicting demand for vaccines; often, the demand is determined by disease outbreaks.

Transboundary conflicts can preclude access to potentially large markets for vaccines. The national governance changes that have led to the emergence of counties could result in discontinuation of existing policies on vaccine production and supply.

Table 12: SWOT Analysis of the vaccine industry in Kenya

Strengths	**Opportunities**
▪ A large vaccines market exists for diverse livestock species ▪ A growing livestock sector with the poultry industry growing fastest ▪ Government regulatory framework is good and there are no impediments as long as one follows the rules ▪ Established public and private sectors distribution system for vaccines with good liquid N and refrigerator cold chain systems i.e. basic infrastructure ▪ Well trained (AHITI and University/College)and experienced animal health service providers ▪ Goodwill from policy makers	▪ Large livestock demand for vaccines not fully exploited ▪ Potential local and regional markets ▪ New bio-technologies now available ▪ A thriving private sector involved in warehousing and distribution services ▪ Political goodwill and an improving regulatory framework ▪ New entrants from India, China, Israel and Europe offer opportunities for more competition and efficiency in the Kenyan vaccine sector. ▪ Competitors have novel & often low cost products thus opportunities for a competitive environment.
Weaknesses	**Threats**
▪ Private sector competing with public sector subsidized KEVEVAPI ▪ Inadequate road infrastructure, tools and cold chain equipment ▪ Low staff morale arising from poor terms and conditions of service ▪ Weak capacity in quality assurance and emergency preparedness ▪ Inadequate policy and legal framework especially on private sector crowding-in ▪ Poor management information systems ▪ Exploitation of farmers by service providers hindering adoption e.g. exorbitant pricing.	▪ Insecurity in ASAL livestock producing areas (Mandera, Samburu, Isiolo etc.) ▪ Land subdivision, corruption, unfair trade and bad business practices ▪ Environmental degradation and natural calamities that threaten livestock herd growth, particularly in the northern livestock producing areas ▪ Trans-boundary conflicts, for example, in Turkana/Uganda, Mandera/Somalia, Samburu/Ethiopia

4.2.2 Key value chain players and partners

The key vaccine producer, KEVEVAPI, was formed in 1990 by the merger of the Vaccine Production Laboratory (VPL) at Embakasi, KARI Veterinary Research Centre at Muguga and the Veterinary Research Laboratory at the DVS Headquarters at Kabete. KEVEVAPI owns vaccine seed stock and produces vaccines for various cattle, goats, pigs, poultry and sheep diseases including FMD, CBPP, CCPP, RVF, blue tongue disease, lumpy skin disease and ovine rinderpest (Table 13). KEVEVAPI has the national mandate to produce, market, and distribute good quality veterinary vaccines and is competitive despite the availability of imported vaccines. In 2013, KEVEVAPI produced 13 key vaccines that cover the important farm animals. These were: 2 vaccines for cattle only; 1 for cattle and sheep; 1 for cattle, pigs and sheep; 1 for goats only;3 for poultry; 2 for sheep only; 2 for sheep and goats; and 1 for turkeys. The Institute's quick response in production of recent RVF vaccine greatly influenced the control of RVF epidemics in both Kenya and Tanzania.

The GoK has the ambition to scale-up vaccine production by KEVEVAPI for endemic diseases to supply these nationally and regionally and to create reserves for strategic use. In fact, KEVEVAPI plans to expand vaccine production. Other vaccine service providers mostly distribute vaccines on behalf of, or sourced from, international companies (Table 14). All the international companies are supplying vaccines through local distributors.

Apart from KEVEVAPI, there are other organizations and companies in East and southern Africa that produce and supply vaccines. These other producers that target endemic diseases in East Africa are GalvMed (based in Botswana and Malawi) and Onderstepoort Biological Products (South Africa).

There are several private sector suppliers of vaccines in Kenya including Bimeda Ltd, Coopers Kenya Ltd, High Chem Ltd, Laprovet, Twiga Murphy Ltd, Sidai Ltd, Ultimate Vet and Ultravetis. New market entrants include India and Chinese companies registering in Kenya. The companies mainly bring in poultry and dog vaccines, particularly Gumboro, Newcastle disease, infectious bronchitis and fowl pox vaccines.

Some of the poultry vaccines including those for Newcastle disease and fowl pox are also produced by KEVEVAPI. This is probably an indication that the demand for the vaccines exceeds the supply from KEVEVAPI. For small stock, Coopers supplies PulpyVax and Blanthrax vaccines for control of pulpy kidney, and black-quarter and anthrax, respectively.

Table 13: KEVEVAPI vaccine types and target species, vaccination frequency, storage conditions, and use precautions

Vaccine	Disease Controlled	Animal Species	Status/Form	Revaccination Frequency	Storage Temp. °C)	Shelf-life	Precautions
AVIVAX™	Newcastle Disease	Poultry	Attenuated, freeze dried	6 months	4 -20	1 month 2 years	-
BLUVAX™	Blue tongue disease	Sheep	Attenuated, freeze dried	Yearly	4 -20	1 month 2 years	Do not vaccinate ewes in first half of pregnancy
CAPRIVAX™	Contagious caprinepleuropneumonia	Goats	Inactivated Mycoplasmal F38	Yearly	4	9 months	No freezing
CONTAVAX™	Contagious bovine pleuropneumonia	Cattle	Attenuated, freeze dried	Yearly	4 -20	1 month 2 years	Do not freeze suspension after reconstitution
FOTIVAX™	Foot & mouth disease	Cattle, pigs & sheep	Inactivated suspension	4-6 months	4	1 year	No freezing
FOWLVAX™	Fowl typhoid	Poultry	Inactivated suspension	-	4	1 year	No freezing
LUMPIVAX™	Lumpy skin disease	Cattle	Attenuated, freeze dried	Yearly	4 -20	1 month 2 years	-
ORFVAX™	Contagious pustular dermatitis	Sheep	Attenuated, freeze dried	Yearly	4 -20	1 month 2 years	-
PESTEVAX™	Pestes des petits ruminants (ovine rinderpest)	Sheep & goats	Attenuated, freeze dried	Yearly	4 -20	1 month 2 years	Use immediately on reconstitution,keep cool.

POXVAX™	Fowl pox	Poultry	Attenuated, freeze dried	Yearly	4 -20	1 month 2 years	Use immediately on reconstitution, keep cool
RIFTVAX™	Rift Valley fever	Cattle & sheep	Attenuated, freeze dried	Yearly	4 -20	1 month 2 years	Do not vaccinate pregnant ewes. Infectious to humans.
S & G VAX™	Sheep & goats pox	Sheep & goats	Attenuated, freeze dried	Yearly	4 -20	1 month 2 years	Use immediately on reconstitution, keep cool
TURKEYVAX™	Turkey pox	Turkey	Attenuated, freeze dried	Yearly	4 -20	1 month 2 years	-

GALVmed and VACNADA donor-funded programs support vaccine production in at least eight African countries (Kenya, Cameron, DRC, Ethiopia, Ghana, Mali Senegal and Botswana) through upgrading vaccine laboratories and capacity building in business management of vaccine production. They have supported KEVEVAPI in capacity building.

Table 14: International and Kenyan companies supplying and distributing vaccines, respectively.

International Supply Company	**Local Distributor**
Bimeda Europe	Bimeda
Zoetis South Africa	Coopers Kenya Ltd
	Cosmos
	Eagle Vet
	HighChem
	Murphy Chemicals
Laprovet	Ultravetis
GALVMED, India (NCD)	Sidai Ltd
China, India	Twiga Chemicals Ltd
CEVA	Unga Farm Care

While the vaccines supplied by these companies are imported, it is not clear how the companies established the demand for the vaccines. Because such statistics are often considered to be company secrets, so far it has been difficult to get data from them. Again, it has also been difficult to establish the vaccine market share of the individual companies. However, most companies are supplying vaccines that are not available from KEVEVAPI.

4.2.3 Vaccine distribution systems/channels

As reported under vaccination services, vaccine distribution is via government programs, particularly during outbreaks of key diseases including notifiable diseases. Farmers can also privately access vaccines from KEVEVAPI or private suppliers that are mostly international and local veterinary companies.

The public sector has plans to support vaccine distribution. KEVEVAPI has not sold vaccines directly to farmers because they are prescription items. When vaccines are distributed to counties, in some instances they are distributed free of charge while in other instances they are offered on a cost share basis or sold to recover the full delivery cost.

4.2.5 Cold chain vaccine inputs provision systems

Some key inputs from vaccine production and distribution include eggs, animals, liquid nitrogen supply and other cold storage equipment. The lack of a liquid nitrogen cold-chain in most of the farming ares is a constraint that should be addressed to reach a wider market.

4.2.6 Vaccination support services delivery

Delivery of vaccination services is a key component of promoting increased vaccine use. Apart from vaccine services being provided by government and private sector agencies, do-it-yourself vaccination options should be promoted among farmers that have cold storage chains or in cases where the vaccine does not need cold storage. Farmer groupings including MCCs that have cold storage facilities could be nodal points for supply of vaccines and services. In Kenya, the SIDAI Ltd and KAGRC appointed agents also have a reliable liquid nitrogen cold chain that can be used for, for example, ECF vaccines.

According to KEVEVAPI, most of the vaccine administration services are undertaken by veterinary authorities.

4.2.7 Training and knowledge transfer systems, extension services, and recording

There is no specific training on the vaccine production, distribution and use other than as a component of veterinary training programs. In order to promote wider use of vaccines, and hence increase demand, such training should be considered. Through public sector support, relevant curriculum should be included in formal veterinary training institutions. However, vaccine production and distribution private companies should consider offering embedded services to enable distributors to be aware of best practices. In addition, the private companies should support training programs for farmers to ensure proper vaccine handling and use, and hence promote increased vaccine demand. According to KEVEVAPI there are public sector programs creating awareness on importance of vaccine use adoption, availability and correct use. Apart from KEVEVAPI, most vaccine suppliers do not offer embedded extension services.

4.2.8 VP sub-sector institutions, associations, governance and policies

Some of the vaccine sub-sector institutions have been described above. These include KEVEVAPI which is the sole vaccine production unit of the GoK. However, the overarching responsibility for vaccine issues lies with the Department of Veterinary Services which is the custodian of vaccine policies and governance. In general, the existing GoK policies are favourable, and do not preclude private sector participation in the vaccine business. Also, in order to preclude market distortions, to establish if in due course it will privatize KEVEVAPI or assign it to produce vaccines for some market segments (e.g., the very poor farmers that may not afford commercial vaccines). KEVEVAPI welcomes partnerships within the Gok Public Private partnership Act framework.

Apart from associations of farmers, veterinary practitioners and farmer groups, there are no specific associations and forums dealing with vaccine issues. There is need to have specific forums where all stakeholders in the VP sub-sector can meet and discuss issues affecting the sub-sector. This is critical to, among others, create awareness on threats to the sub-sector, register members, and hence keep in check distribution of counterfeit vaccines and unregistered vaccine suppliers. Those that intend to invest in this sub-sector should advocate for establishment of these forums.

4.2.9 Value chain and asset financing including credit facilities for suppliers and users

Availability of direct financing of VP value chain activities is not well documented. Apart from ad hoc support to curb disease outbreaks, there are no direct financial products financing VP value chain activities other than through cattle loans and disease control packages. For example, in the past USAID funded importation of RVF vaccine to control an outbreak. Also, cattle insurers insist on vaccination

schedules for cattle as a precondition for giving insurance coverage. Clearly financing of the VP value chain is not a stand-alone package. There are cases where farmer groups including East Africa Dairy Development MCCs that have offered vaccines and farmer payment is through a milk check-off payment system in which the cost of the item is deducted from the farmer's milk cheque.

4.2.10 Access to good quality and reasonably priced equipment

The equipment for vaccine production is specialized. As a result, it is largely imported. This should be taken into account when investment in vaccine production is considered. Equipment for distribution of vaccines, that in most cases is needed to maintain a cold chain can be integrated with semen distribution equipment including liquid nitrogen containers. The vaccine distribution is not usually the responsibility of distributors who largely provide a warehousing facility.

4.2.11 General constraints, policy and regulatory framework impacting on VP value chain, including import regulations

As stated in the ToR and in the SWOT analysis, the vaccine production value chain in Kenya faces constraints that can compromise the supply of good quality vaccines. Among these constraints is the market distortion brought by the GoK's participation in vaccine production and sale at subsidized rates. In this regard, KEVEVAPI is the only organization in Kenya involved in vaccine production for the livestock sector. Specifically, as a consequence of an inadequate production facility, and inadequate quality assurance and biosecurity, KEVEVAPI's Good Manufacturing Practices (GMP) are in question. This reduces the competitiveness of its products on the market. In general, the vaccine production facilities at KEVEVAPI are regarded to be obsolete, and hence need to be revamped. This has been acknowledged; hence, the GoK is looking for funds to undertake the required changes.
There are complaints of counterfeit vaccines reaching the market.
Other constraints affecting the VP value chain include lack of a liquid N cold-chain, lack of awareness on merits of vaccine use, relatively high cost of imported vaccines, the need for expert veterinary support, and limited availability of vaccines.
According to KEVEVAPI, when vaccines are being imported the relevance of vaccine strains to the local disease strains, availability of cold chain and accessibility of the manufacturer are considered. It further claims that, in general, veterinary policy should be amended to give more support to vaccine production.

4.3 Financial Analysis of the Vaccine Production Value Chain

After the interviews, it became clear that the costs of production and return vary with vaccine types produced, and the level of technology. As a result, there is no useful generic investment and operating costs, revenues and returns. However, respondents in VP said that the major vaccine production costs are fixed costs including electricity and cold chain maintenance costs, and the cost of imported raw materials. Most of the raw materials for vaccine production are imported. Capital costs are largely for land and buildings.

4.4 General Analysis of Investment Opportunities in the Vaccine Production Value Chain

For vaccine production, we conceptualize that while disease outbreaks threaten growth and productivity of the Kenya dairy sector, vaccine use is low as a consequence of inadequate disease surveillance, quarantine programs, prevention and control. In addition, vaccines developed should be competitively priced, meet international quality standards to tap international markets, and, locally, vaccines should be channeled into an efficient cold chain distribution system that is accessed by the majority of farmers.

Based on responses, particularly from KEVEVAPI and the DVS, there is a high demand for vaccines in Kenya and in the East African region. In fact, KEVEVAPI is unable to meet the regional vaccine demand

and local demand for some vaccines, particularly poultry vaccines. Private sector investment opportunities are in vaccine warehousing, particularly for supply of poultry and some key vaccines that KEVEVAPI is unable to fully supply.

Our interviews revealed gaps in the supply of vaccines for RVF and brucellosis, particularly the S19 vaccine that has potential demand in excess of 2 million doses per year. However, the RVF vaccine had the third largest sales for KEVEVAPI; hence, KEVEVAPI is trying to meet the high demand.

Farmers also require long-lasting vaccines. It was suggested that oil-instead of water-based vaccines are desired by farmers because they maintain potency for longer periods than the water based vaccines. The oil-based vaccines are not sufficiently available.

While there are more investment opportunities in warehousing vaccines, KEVEVAPI is interested to partner with private companies in vaccine production and distribution. This is consistent with the Public-Private Partnership Act (Government of Kenya, 2013). Consistent with this partnership drive, KEVEVAPI has also been supported by GalvMed and Vacnada to improve production capacity.

French companies including Laprovet and CIVA and a few Dutch companies have used this approach of distributing their products through local agents. The CRV-KAGRC is a best practice that could be adopted by Dutch companies. In this instance CRV is providing technical expertise including taking a lead in areas such as genomic bull evaluation.

CHAPTER 5: ANALYSIS OF INVESTMENT OPPORTUNITIES IN THE AI AND VP VALUE CHAINS FOR THE DUTCH PRIVATE SECTOR

The AI value chain is more developed and competitive than the vaccine value chain. The AI market is well-defined and investment opportunities are clear. As pointed out by KEVEVAPI, the VP value chain still has an ill-defined market and unpredictable market. Vaccine supply has largely been driven by disease outbreaks. Entry barriers and competition in the AI and VP businesses are largely similar but the AI business has more barriers than the vaccine business.

5.1 Dutch Private Sector Opportunities for Investment, and Needs in the AI VP Value Chains

Generically there are investment opportunities in the AI value chain, particularly in the distribution and production of AI consumables that would be open to the Dutch private sector. Some Dutch companies already supply semen through local distributors and have strength in the AI business. However, we were unable to identify Dutch companies that are willing to invest in the VP value chain. In fact, two of our Dutch interviewees confirmed that there were hardly any Dutch vaccine production companies that had invested in East Africa. The lack of Dutch presence is partly a consequence of mergers of Dutch veterinary pharmaceutical companies with mainly American pharmaceutical companies. In this group is the MSM Animal Health company that is a merger of several companies including Schering Plough and Merck Animal Health.

The needs of the Dutch AI private sector were considered through responses received from a few AI companies. There were no responses received from VP companies and purported experts. All the vaccine experts we were referred to declined that they had expertise in VP. From this anecdotal evidence, it is therefore unlikely that there is a critical mass of Dutch VP companies to generate interest in investing in the VP business in Kenya.

For AI contributions, there was concern from some Dutch respondents that investments in AI and genetic improvement would not be worthwhile until the current potential of cattle is exploited through improved farm management and feeding. They further suggested that well trained AISPs and large farm owners were required for the benefits from AI to be realized. The respondents reported that Dutch companies have highly developed semen sexing and embryo transfer technologies that could be commercially provided in Kenya.

One Dutch company was interested in expanding business to Ethiopia, Rwanda, Tanzania, Sudan and Uganda. Expansion to Ethiopia or Rwanda was the immediate priority. The company intended to use the business model that has been implemented in Kenya. All respondents said that investment levels were dependent on the selected start up activities and it is unlikely that companies would release this information. Some Dutch companies are interested in partnerships with public institutions and private companies. However, the precondition is that the public sector institutions should operate commercially and along realistic business models.

Based on experience in Kenya and elsewhere in Africa, some Dutch companies noted the slow process of developing a new activity. As a result, it is important to continue closely monitoring and controlling activities and pushing for system and policy changes. Related to this is the general lack of commitment responsibility by African partners for success of an introduced activity.

5.2 Potential AI and VP value chain segments for investment

The specific value chain segments for investment in the AI and VP value chains are numerous but the AI value chain has a more diverse range of segments that ranges from semen production, in collaboration with local bull studs, and local manufacture of AI consumables to warehousing and semen distribution.

5.2.1 AI investment and market opportunities

Potential AI value chain segments for investment in Kenya include:

- Semen production: Kenya semen demand supply gap is estimated at 1.6 million semen units. However, viability of a bull stud and potential to export to East Africa countries need to be determined to achieve a target of not less than three million semen units for sale.
- Strategic alliance or partnership with other privately licensed local entrepreneurs intending to start a bull stud for localized semen production, as demonstrated by the CRV and KAGRC partnership. This has the advantage of tapping local knowledge and culture. It is also a win-win situation where the Dutch bring in expertise and business experience. Such an alliance can circumvent product prejudices; for example, the outbreak of Bovine Spongiform Encephalitis (BSE) led to bans, until a few years ago, of semen imports from Europe giving and advantage to local semen producers and importers from North America.
- In general, Dutch companies should set-up in existing institutions such as the KAGRC bull stud. This is on condition that the parastatal bodies agree to operate on full private business model with no subsidies or interference from Government of Kenya. They should consider providing after-sales service for specialized equipment and special technology to existing institutions. Overall, warehousing of products through local partners is the best approach for Dutch companies instead of engaging in manufacturing. As a result of high import duties, Dutch companies should consider importing raw material or singular vaccines that are blended locally. Coopers Kenya Ltd is blending some imported vaccines in Kenya.
- Full privatization and outright acquisition of the local government parastatal bull-stud KAGRC could be an option. However, this requires gathering evidence to illustrate the benefits of full privatization and, hopefully, convince the GoK to fully privatize the AI industry. Bulls can be imported as embryos and subjected to local genomic tests and progeny testing.
- where it can lease land, create disease fee zones and holding grounds to produce good quality genetics that meet international standards and to enable export of local genetics that can withstand drought, and work well in arid and semi-arid environments. To this end, the GoK is encouraging partnership for genomic bull testing, sexed semen technology and assistance in performance recording. All these arrangements can be made under the PPP Act. However, there is a feeling that KAGRC is too strategic, and hence if fully privatized can fail to serve the majority smallholder farmer population whose buying power is weak.
- Distribution of AI equipment, heat synchronization hormones for fixed time AI, and development of locally adapted genetics
- Development/Establishment of a good quality genetic, liquid N and breeding inputs distribution network that also delivers AI services at farm level, this can be achieved by establishing business alliances with local genetic importers.
- Establishment of an AI and breeding data management company such as Dairy Herd Improvement in USA and data management and breeding software development services. This not functional in Kenya and yet this service strengthens breed associations.
- Commercial heifer breeding farms that also double-up as high quality bull breeding farms. Opportunities for heifer breeding arise from a large local and regional (Burundi, Ethiopia, Rwanda, Tanzania, Southern Sudan and Malawi) demand for breeding heifers.
- Generating embryos for use in embryo transfer programs that can be enhanced by a large base of potential surrogate mothers, and potential use of sexed-semen crossbred heifers that outperform pure breeds in some environments. The young farmers are a potential market for good quality bred animals.
- The proposed cattle identification requirement will also offer opportunities to engage in the ear tag manufacture and supply business, and traceable bolus and sampling tissue collection for diseases and genomic studies.

5.2.2 VP investment and market opportunities

- Strategic alliances with KEVEVAPI in vaccine production can be considered.
- Vaccine blending, warehousing and distribution are the entry points into the vaccine business in Kenya and potentially East Africa.

5.3 Conducive Factors for Investment

- Kenya is one of the key logistical business conduits into East Africa. Strategically, market entry should be staged to begin with appointment of local stocking distributors or agents that are supported to understand and promote their businesses. Entry and registration of the foreign investor follows when market structures are functional and business sales have grown sufficiently to warrant capital injection for expansion and production.
- The GoK is willing to engage in public private partnerships (PPPs) that are backed by an act of parliament.
- Depending on the nature of business, in both the AI and VP value chains entry barriers could be low. In both AI and VP, simple businesses could be based on warehousing from imports and dispatching products from distribution outlets. However, if the business will be at the level of production, the investment required to produce semen for AI is larger than what would be required for vaccine production. Also, maintaining bull studs and the performance recording network can have immense maintenance costs. The Dutch and Kenyan governments have a bilateral agreement on heifer importation from The Netherlands that was signed in 2014. This can be a business which can be buttressed by AI using sexed semen. There is evidence that there is high demand for good quality heifers that is not being met. It was noted that buyers from the region (e.g., Tanzania & Uganda) have to book for heifer purchases from Kenya one year in advance. As a result, heifer prices are high (250,000 KES/heifer). This is an opportunity for Dutch companies to fill this gap.
- The GoK and KEVEVAPI recognize the needs of the VP sector and have plans to provide additional support. The counties are also taking disease control seriously that has led to vaccine purchases accounting for 34% of KEVEVAPI sales.
- Compared to neighbouring countries, Kenya has a highly educated skilled labour that is costly by developing world standards.
- Cellphone technology has enhanced rural businesses.

5.4 Investment constraints, entry barriers, and competition

- While in general labour is highly skilled, a large portion of the population is below 35 years of age and is relatively unskilled, and subsists in an employment environment that offers few opportunities.
- Specific challenges include lack of verifiable and therefore reliable planning data particularly on market size and possible stratifications. The Kenya dairy industry is famous for being a smallholder system thus characterized by fragmentation or disaggregation which can increase transaction costs, undiscerning customer and business risk. Poor fiscal budgets have meant weak standards and hastily planned exits resulting in partial privatizations. To date, this is being complicated by a devolved County governance system with inadequate plans on AI sub sector regulatory frameworks. This and investments under the devolved governance system presents business risks clearly indicated as weak or inefficient market signals. Kenya's AI sub sector is clearly a price sensitive market where breeding takes place in the absence of milk buyer market incentives.
- Low mechanization and poor rural infrastructure make transport investments costly particularly motorized vehicles for AISPs in rural areas. Lack of appropriate transport for bad roads, particularly during rain seasons is often blamed for poor AISP service delivery.
- Land unavailability and costs are increasing at a fast rate.
- Lack of industry relevant data that precludes business planning and assessment of viability options.
- High interest rates and demand for collateral discourage long-term borrowing and increase risk of defaulting.
- There is competition from Indian and Chinese companies that, in general, bring cheaper technologies than those from Europe and western countries. While European imported products may be superior in quality, the market in Kenya is price sensitive, and hence normally there is a race to the bottom of the pyramid. In this regard, buyers opt for the low cost products without regard to quality. Product loyalty is not strong.

- Potential investment risks in the vaccine business at the moment could arise from an ill-defined market. However, this could be surmounted through a graded investment approach, that, as described above could start with distributing imported vaccines.
- Continued subsidized vaccine production by KEVEVAPI can distort market prices. KEVEVAPI can potentially produce any vaccine. This can create risks for private vaccine producers and suppliers. Also, the presence of donors that are free to source vaccines from elsewhere and distribute vaccines free of charge is always a potential threat to business.

5.5 Potential AI and VP value chain Investment Risks

The potential investment risks can be divided into national, industry and internal business risks and are elaborated below.

5.5.1 National risks

- The disparate quality standards and GoK taxes and charges for imported AI and VP products that can be revised without consultation constitute a business risk and an unfair playing field when compared with local similar products. This has to be considered in any investment in AI and VP product warehousing and distribution.
- Perennially, the private sector has competed against government subsidies and other public sector market distortions. Any investor has to factor-in this ever present possibility and devise strategies to deal with it.
- Inexperience and low capacity at senior public sector administration levels are prevalent; for example, obsolete zoo-sanitary import permit requirements and lack of understanding of new technologies including genomics evaluation and sexed semen product can delay imports. Currently, it takes two to three weeks to obtain a semen import permit due to delayed approvals.
- As stated above, dairy has been the fulcrum for the AI business; unfortunately, dairy production is being threatened by declining farm sizes leading to insufficient fodder production and water availability.
- The poor national security should be considered, particularly when delineating operation zones.
- Hedging should be considered by any investor in order to deal with the frequent KES currency exchange fluctuation, largely a declining value, leading to price instability.

5.5.2 Industry risks

- There is paucity of reliable industry data that precludes prudent planning and management; as a result, investors should devise their own means of collecting vital data.
- Because 80% of Kenya's dairy farmers are smallholders that are dispersed across large areas and lack of economies of scale, business transaction costs are high.
- Good quality extension services are limited, and hence investors in both the AI and VP value chain should devise strategies to convey product and technical knowledge to client farmers.
- Production of milk and other livestock products can be seasonal; as a result, such seasonality should be considered in any investment option.

5.5.3 Internal risk

Internal business risks will be directly associated with company management.

- Challenges to be addressed include but are not limited to low business skills and lack of specialized talent in breeding. In addition, inadequate staff mentoring results in majority of workforce underperformance and leading to bad business practices.
- In Kenya, there is a culture of limited staff loyalty and integrity. Often, staff members tend to out-compete their employers by running parallel businesses, a common conflict of interest. Furthermore like all human beings, staff capacity building fuels search for greener pastures and, in Kenya where professional talent is scarce and NGOs seeking talented staff are many, staff mobility is high.

5.6 Strategies to Address Constraints and Enhance Investment Opportunities

Investors in the AI and VP value chains can partly address the constraints and enhance investment opportunities through the following strategies.

- Targeting farmers and ensuring market segmentation of innovator farmers, followers and laggards
- Facilitation of farmers education on best AI and vaccine technology practices including benchmarking through farmer exchange visits
- Facilitation of the formation of elite farmer clubs or associations capable of performance recording to enhance demand for good quality products and services
- Facilitation of creation of more industry platforms that constantly address sector issues
- Use of competent and trustworthy staff of high integrity, agents/distributors and AISPs
- Supply appropriate cattle genetics to the environment because the sole use of the Holstein breed is increasingly being regarded as inappropriate for most East African countries. In fact, the Holstein is undesirable as it requires large quantities of scarce feed and water, and does not suit all production environments and existing management competence.

5.7 Potential Complementarity of AI and VP Value Chains

Clearly, currently there is more competition in the AI than VP business in Kenya. However, the VP business has a broader market that includes all farm animals including cattle. In addition, there is a small market for companion animal vaccines.

There is certainly some complementarity in the AI and VP value chains. In this regard, both value chains serve cattle farmers. They both rely on a cold chain for product distribution that has potential for integration. Last mile distributors of both products can be the same; for example, veterinary agents can provide AI and vaccination services. In addition, both AI and vaccine supply can be funded through the same financial support systems anchored at key farmer groups including MCCs. However, at semen and vaccine production level there is no apparent complementarity.

CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

Based on desk studies and contacts with stakeholders in the AI and VP value chains, there is substantial information on the AI compared to the VP value chain. In general, getting relevant statistics, particularly VP value chain data from private companies was not easy. As a result of commercial interests' protection, there is reticence on release of vaccine production and distribution statistics.

However, the total value of the AI business exceeds 11 million USD at the current 18% of breeding female dairy herd AI use with a potential to generate over 37.6 million USD at 60% of dairy cattle breedings. The value of the vaccine business is currently estimated to be about 13 million USD per annum. Projections are difficult to compile because demand for vaccines has been unpredictable partly because it has largely been influenced by sporadic disease outbreaks and there is no central vaccine distribution data repository. The current annual vaccine business at KEVEVAPI is valued at about 3 million USD. It is estimated that private sector alone commands an annual 10 million USD vaccine business; however, in the absence of a central vaccine distribution data repository this could not be confirmed in this study.

While the market for AI supplies and services is well developed, the market for vaccines is ill-defined and not predictable and is largely dependent on disease outbreaks. Based on the populations of livestock, there is limited vaccine distribution of vaccines. It is obvious that a cattle population of 27 million would require annual vaccine doses in excess of this population but KEVEVAPI supplied a total 27 million doses of vaccines for all the livestock species which clearly shows a huge gap in vaccine supply. Both KEVEVAPI and the GoK accept that the national and regional demand for vaccines is not being met. This demand is likely to be met when KEVEVAPI engages partners that can improve its capacity including a technological upgrade of its facilities.

While there is anecdotal evidence of a potential vaccine demand, such investment opportunities would be more apparent if the GoK establishes vaccine production and distribution data recording systems. Apart from this GoK expectation, stakeholders in the VP sub-sector could also establish farmer needs and demand from created stakeholder forums.

While investment at semen and vaccine production levels can be considered, initial investment by Dutch companies should first be at the warehousing and distribution level (supply through product importation) to establish distribution channels and demand before investing in production facilities. Consideration should be given to potential risks that arise from subsidized or free products that can be supplied by the GoK and donor programs.

While it is perceived that Dutch companies have interest in investing in the Kenya AI and VP value chains, it seems there is more interest in the AI than the VP value chain. It is apparent that most Dutch pharmaceutical and vaccine companies have merged with large international companies, mostly American companies. It is probable that this may dilute the Dutch agenda of tapping the vaccine business in Kenya.

6.2 Recommendations

There is potential for Dutch companies to invest in the semen and vaccine distribution and companion product manufacture business.

- Strategically, it is essential for investors to work with local partners to understand the markets before fully engaging and making heavy investments. All breeding products from semen to supplies should be tailored to the markets for pack size/specifications.
- Given that breeding programs take long to realize results, this makes the AI sub-sector vulnerable to public sector and donor investments that often distort markets. In this regard, it is important to

scope the NGOs working in the area to form strategic buying-down risk partnerships or alliances, and hence preclude market distortions.

- The investment plan and prevailing business models should be dynamic and easily modified in line with evolving dairy market dynamics.
- Because the AI business is largely anchored on the dairy sub-sector, the major changes in the sector that include the advent of international milk processors such as through the Danone and Brookside joint venture, investors should be prepared for long-run business model modifications.
- In general, only on condition that the GOK allows the Parastatal entities to operate on a total business model where the business entities do not received government subsidies not allow interference from the GOK Dutch companies can invest in the production business by setting-up in existing fully privatized institutions such as KEVEVAPI and KAGRC bull stud where they can offer their competencies without investing substantial capital until opportunities for full buy out arise.
- Dutch companies should consider investing in local AI companion product manufacture. They should also consider investing in after-sales service provision for specialized equipment and special technology to existing institutions (e.g., liquid N generation equipment after sales service).
- Initially, warehousing of products through local partners is the best approach for Dutch companies instead of engaging in manufacturing. As a result of high import duties, Dutch companies should consider importing raw material, and in the case of vaccines singular vaccines that are blended locally as is being done by some local vaccine suppliers.
- Dutch companies should exploit existing bilateral agreements between the Dutch Government and the GoK; for example, the heifer supply agreement.

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