Livestock production and marketing have been hampered by unavailability and accessibility to livestock technologies, and information sharing. The overall objective of this study was to assess a multi-institutional model for enhancing uptake of livestock technologies in Isiolo and Kajiado counties. The key parameters assessed were priority livestock constraints; technology needs; stakeholder partnerships; and technology delivery platform. Data were collected from 451 households belonging to Kenya Climate Smart Agricultural Production KCSAP groups red meat value chain, Common Interest Groups and Most Vulnerable Groups (CIGs and VMGs) using semi structured questionnaire; Focus group discussions with groups, key informant interviews with public and private sector actors.
The results showed that in both Kajiado and Isiolo Counties, the major livestock technology needs were: pasture, water, access to veterinary vaccines, capacity building of groups; training of paravets to support in delivery of veterinary services; information sharing platform and market infrastructure. Multi institutional technology exhibitions consisting of public and private sector actors were held in Kajiado and Isiolo Counties linking KCSAP pastoralist groups to technology and service providers. To enhance sharing of information, a mobile application(MITDP) was established linking CIGs and VMGs leaders with KALRO, KEVEVAPI, County Governments of Kajiado and Isiolo departments of livestock production and veterinary services; suppliers of drugs, vaccines and equipment; water technology suppliers; Agro-vets and Non-governmental organizations along the red meat value chain.
Multi-institutional, livestock technologies, linkages, exhibitions.

In Isiolo and Kajiado Counties, red meat offers an opportunity for increasing household food, nutrition and income security. However, past interventions have not been successful in delivery of livestock technologies to address perennial constraints due to single organization approach, often each with its own interests (Simon et al.; Thomas et al.; Reyes et al.).
Availability and accessibility to livestock technologies, and information sharing for enhancing red meat production and marketing is a major challenge, despite numerous research and development interventions undertaken in the ASALs (Onduso et al.; Thomas et al.; Fernández–Rivera, Hiernaux and Williams). Productivity and commercialization are constrained by inadequate extension services, long distances to access production inputs like drugs and vaccines, animal breeds, packaging – mismatch in demand and supply, and information (Gelan) as reported also in other livestock sectors (Yilma et al.; Mochabo et al.). Previous studies suggest that single organizational interventions in ASALS have had less impact in solving livestock production constraints (Simon et al.).
There is need to determine priority livestock technology needs and establish a multi institutional partnerships to facilitate and promote availability and access to technologies and information. The partnerships between livestock technology providers and KCSAP groups are likely to create more awareness among pastoralists on the types of livestock technologies available from various

providers. In order to enhance information sharing such as disease reporting, availability of drugs and vaccines, feeds and feed conservation methods, breed improvement, water technologies, this requires a robust and efficient mechanism in facilitating information flow. Development of a mobile platform was thus prioritized for purposes of information sharing among institutions and partners. Increased awareness and access to technologies will be a key adaptation strategy against drought and livestock pests and diseases which often result in loss of livelihoods due to death of livestock.

[illegible]

The study was carried out in Dalalekutuk ward of Kajiado County and in Oldonyiro and Ngaramara wards of Isiolo County. The study used exploratory designs to assess the livestock technologies needs of pastoralists. These were done through obtaining insights from various stakeholders who included livestock keepers, sub-county administration, animal health, animal production service providers and input suppliers.

[illegible]

The sample size needed was determined using formula suggested by (Mugenda and Mugenda) and (Kothari).

For known target population sizes---------- $n = \frac{N}{1+N\,(e^2)}$

Where n = required sample size, N = Estimated population size, e = Acceptable marginal error, which is 5% or 0.05. The human population for Isiolo Sub-County was estimated to be 88,000, while the number of household was 17,600 (ICIDP). The human population for Kajiado Central Sub- County where Dalalekutuk ward is located was estimated be 255,000, while the number of household were 33,400,Kajiaodo County Integrated Development programme (KCDPI). Hence the total number of households where the study was carried out was 51,000. Therefore, using the above formula

For known target population sizes---------- $n = \frac{N}{1+N\,(e^2)}$

The sample size was $51000/1+51000(0.05^{2)}$ = 400. The number of households sampled from this population was proportional to the population of the sub-counties. Of the 400, Isiolo Sub-County contributed 138 derived as 17600/51000*400 while Kajiado Central Sub-County contributed 262 derived as 33400/51000*400

[illegible]

[illegible]

Pastoralist households were randomly selected among KCSAP groups of the red meat value chain in both Isiolo and Kajiado Counties. Semi-structured questionnaires were developed to collect household data and pre-tested in Makueni County for reliability and validity. The questionnaire was uploaded on Open Data Kit (ODK). Ten enumerators were recruitment were per ward. Recruitment was based on the highest education level, gender and diploma in agricultural field was an added advantage. The enumerators were trained on the electronic Open Data Kit (ODK) tool application and modalities for interviewing.

[illegible]

A total of ten Focus Group Discussion (FGDs) with a total of 120 participants (30 men and 90 women) were conducted in KCSAP red meat value chain groups in both Kajiado and Isiolo counties. Four FGDs (48 livestock keepers -11 men and 37 women) were held in Dalalekutuk

ward, Kajiado County. In Isiolo county six FGDs (72 livestock keepers-20 men and 52 women) were held in Oldonyiro and Ngaramara wards.

[illegible]

Fourteen key informant interviews (KIIs) were conducted in Kajiado and Isiolo Counties. In each of the two counties, the KIIs targeted the County Director of Livestock Production, three Animal health services providers, KCSAP coordinator, three ward administrators in the KCSAP wards, three area chiefs, three KCSAP group leaders (CIGs and VMGs) and three Nongovernmental Organization (NGO).

[illegible]

Visits and planning meetings were held with different stakeholders including county departments of livestock, NGOs, Suppliers of veterinary drugs and vaccines, feeds companies, equipment suppliers in both Kajiado and Isiolo Counties. The aim was to validate and assess the capacity of partners for delivery of livestock technologies through a multi institutional approach in the red meat value chain.

[illegible]

Data collected were cleaned to remove outliers. Quantitative data were analyzed using SPSS Statistics (Version 20)(Statistics). Proportions and means for Isiolo and Kajiado were compared using Chi-square and t-test at 95% confidence interval ($p < 0.05$). Qualitative data from KII and FGDs were analyzed based on thematic areas.

[illegible]

The survey assessed 451 one respondents (149 females and 302 males) from both counties. The major priority livestock production constraints in Kajiado County in Dalalekutuk ward were diseases, lack of feeds, limited access to water, inadequate veterinary services, conflict with wild animals and poor management of grazing land. In Isiolo County the priority livestock production constraints were lack of feeds, limited access to water, diseases, inadequate veterinary services, cattle rustlers and poor management of grazing land (Table 1).

[illegible]

[illegible]	[illegible]	[illegible]
1	Diseases	Pasture
2	Pasture	Water
3	Water	Diseases
4	Inadequate veterinary services	Inadequate veterinary services
5	Poor management of grazing land	Cattle rustling/Insecurity
6	Invasive plant species	Poor management of grazing land
7	Human-wildlife conflict	Invasive plant species

Priority livestock diseases in Kajiado, County, Dalalekutuk ward included foot and mouth disease (FMD), anthrax, East Coast fever (ECF) and lumpy skin disease (LSD) for cattle; contagious caprine pleuropneumonia (CCPP) and cerebral coenurosis, peste des petits ruminants (PPR) for goats and enterotoxemia, cerebral coenurosis and heartwater for sheep. In Isiolo County, priority cattle diseases were FMD, trypanosomiasis, ECF and LSD. In goats CCPP, cerebral coenurosis and PPR were reported as key diseases while in sheep enterotoxemia, cerebral coenurosis and heartwater were predominant (Table 2).

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cattle	FMD	1	FMD	1
	Anthrax	2	Trypanosomiasis	2
	ECF	3	ECF	3
	LSD	4	LSD	4
Goats	CCPP)	1	CCPP	1
	Cerebral coenurosis	2	Cerebral coenurosis	2
	PPR	3	PPR	3
Sheep	Enterotoxemia	1	Enterotoxemia	1
	Cerebral coenurosis	2	Cerebral coenurosis	2
	Heart water	3	Heart water	3

[illegible]

Livestock production constraints reasons for their persistence were reported as single organization interventions not sufficient to solve problems, lack of prioritization livestock needs such as water, pasture, diseases control amongst others.

[illegible]

1 Single organization interventions not sufficient to solve complex problems.
2 Lack of prioritization by stakeholders (water, pasture, diseases)
3 Inadequate funding for disease control.
4 Lack of business approach to pastoralism
5 Dependence-syndrome on external support and lack of community ownership of projects.
6 Lack of holistic models that are sustainable

The priority livestock technology needs identified through KCSAP CIGs are indicated.

[illegible]

1 Technologies on pasture production and conservation
2 Water harvesting technologies
3 Drugs and vaccines accessibility
4 Training of community disease reporters and Para vets
5 Technologies on how to control invasive plant species
6 Business approaches for pastoralism: Finishing strategies for red meat
7 Marketing Infrastructure. e,g holding grounds

8 Training on management of rangelands

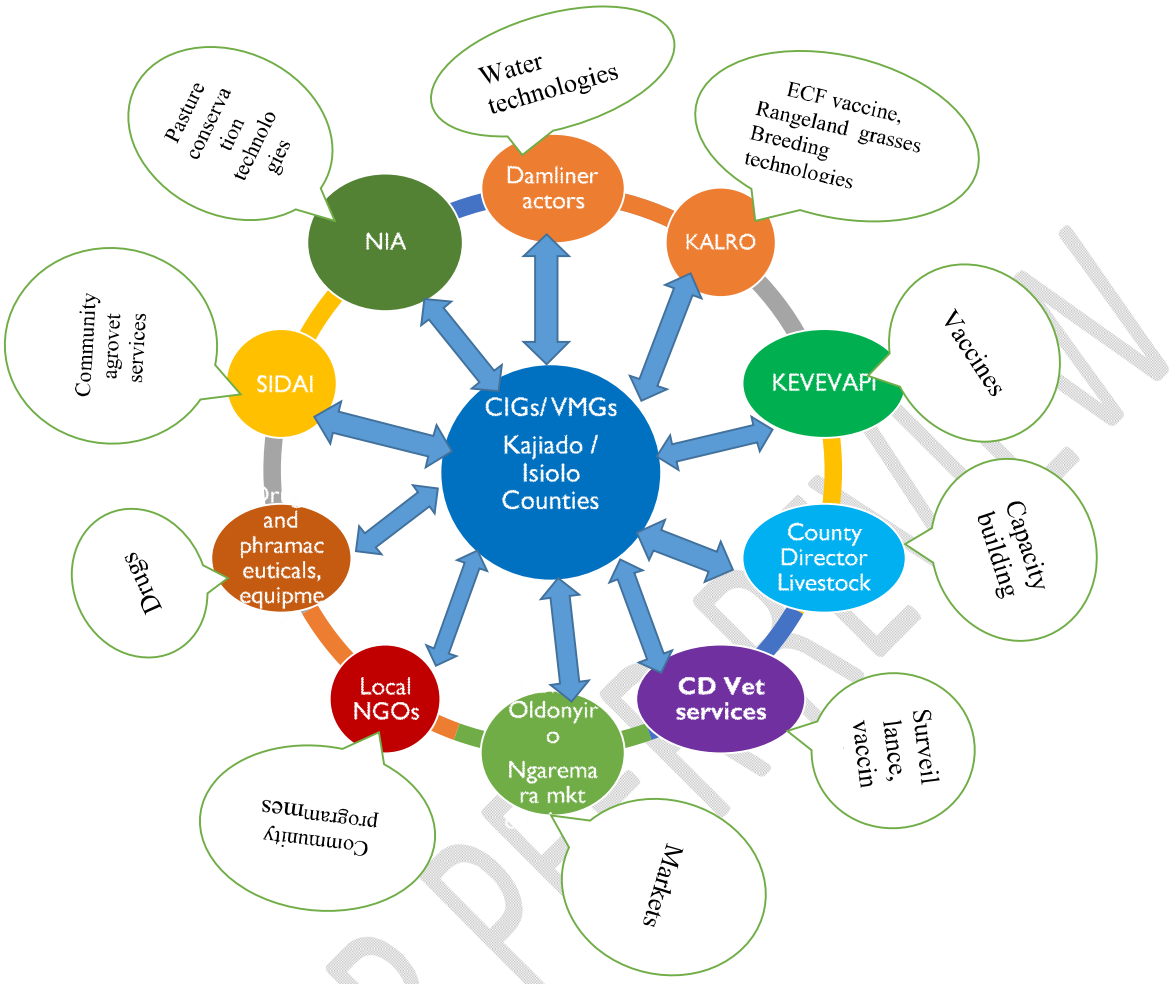
[redacted]

In this study stakeholders were mapped and their roles. The results indicate that technologies by these organizations are available and are able to address livestock technology needs through a multi-institutional approach. The study identified over 20 institutions which included government intuitions, Non-Governmental organizations, Veterinary Pharmaceuticals, Agro-vets and private institutions that were in a position to contribute towards enhanced livestock production.

[redacted]

Multi-institutional livestock technology delivery model was established as shown in Figure 1.
It is purposed as a management practice to facilitate and promote availability and access to inputs, technologies and information sharing through multi -institutional linkages involving private and public partnership through exhibitions. To enhance information sharing, a mobile Application link https://play.google.com/store/apps/details?id=com.kalro.lmitdp.introscreen&hl=en&gl=KE) was developed to link pastoralist groups to technology and service institutions in public and private sector. The platform is for sharing information on disease reporting, drugs and vaccines, feeds and feed conservations, breed improvement, water technologies, small veterinary equipment, marketing and holding of multi institutional technology exhibitions on needs basis.
Through the model, two livestock technologies exhibitions were organized in Kajiado and Isiolo counties in Delelakutuk ward –Sajilon market and Ngaremara ward respectively. The exhibition showcased priority technology needs of the red meat value chain. During the exhibitions livestock and livestock inputs such as drugs, dry hay, hay seeds and salts were sold. Also information was sought by famers from the different stakeholders such as water and pasture conservation technologies.

Multi institutional model for delivery of livestock technologies



[redacted]

The study establishment of multi-institutional livestock technology model, KCSAP group leaders and representatives of service provider organizations agreed to share the information on delivery of technologies through the developed mobile application. In Kajiado County, group leaders will coordinate this initiative and take the lead in organizing exhibitions on need basis, while in Isiolo, SIDAI and KCSAP groups will be the lead actor for sourcing technologies from other stakeholders and organizing grassroots technology delivery initiatives.

[redacted]

The study showed that livestock production constraints are similar. These constraints are not new and have been persistent as reported by past studies in pastoral production systems (Onduso et al.; Mati et al.; Ndathi et al.; Manyeki et al.; Syomiti et al.; Mbae et al.). These findings suggest the need for a multi-institutional approach in the delivery of livestock technologies. The results further indicated that the diseases in both counties were similar. These diseases can be broadly categorized into endemic and transboundary diseases. Similar findings reported livestock diseases ranking as number one constraint affecting goat production (Kipronoh et al.). Fortunately, technologies for the control of these diseases are available such as vaccines and

drugs but have not been accessible by pastoralists. There is therefore a need to establish partnerships in the delivery to control diseases in the pastoral community. In both counties FMD ranked highly due limited disease control initiatives since counties are not allocating money for vaccine and `control strategies.

Livestock production constraints in pastoral ecosystems have been persistent despite many interventions in the past, mainly due to single organization approaches which quite often are insufficient since these constraints are interrelated and hence the need for a multi institutional approach in the delivery of technologies (Kidali et al. 2021). The reason for the persistence of livestock constraints based on the community views were ranked as single organization interventions not sufficient to solve complex problems in rangelands, Lack of prioritization by stakeholders, Inadequate funding for disease control, few veterinary personnel, Lack of business approach to pastoral livestock keeping, Dependence-syndrome on external support and Lack of holistic models that are sustainable. Other studies have shown persistence reasons for livestock constraints (Mohamed; Shanguhyia; Kidali et al.). Research institutions, drugs and vaccine producers experiences constraints at institutional levels that impacted negatively on animal health management (Kidali). Based on the priority livestock technology needs the requirement of a public/private partnership was of essence based on these needs. Hence a multi-intuitional livestock delivery model was essential.

C

Livestock production in both Kajido and Isiolo Counties had a myriad of constraints in which single organization approaches could not resolve as these constraints are interrelated, hence the need for a multi institutional approach in the delivery of technologies. Majority of providers are in major towns, pastoralists are unaware of most of the available technologies as was reported in the study. Increased awareness and access to technologies through Multi-institutional livestock technology delivery models and platforms will be a key adaptation strategy against drought and livestock pests and diseases which often result in loss of livelihoods due to death of livestock. Increased awareness among pastoralists on the types of livestock technologies available from various providers would enable them access priority livestock inputs from suppliers which previously was not possible due to lack of viable partnerships.

Rec

i. Multi-institutional livestock technology delivery model is management practice which is to facilitate and promote availability and access to inputs, technologies and information sharing through multi -institutional linkages involving private and public partnership, through exhibitions and information sharing. It is a holistic approach to solving most the persistent pastoralists livestock constraints in order to achieve increasing household food, nutrition and income and security.
ii. Going forward, using the established platform, members through their group leaders will be able to share information and demand for specific technologies / services directly from providers who are also on the platform. Livestock technology producers will be able to produce according to demand priority, right packages and information.

Gelan, Daniel %J Available at SSRN 3054254. "Services Delivery Constraints in Pastoralist and Agro-Pastoralist Areas of Ethiopia." (2017). Print.
ICIDP, Isiolo. "Isiolo County Integrated Development Plan 2018-2022." Nairobi, Kenya: Government Press, 2018. Print.
KCDPI, Kajiado. "Isiolo County Integrated Development Plan 2018-2022." Nairobi, Kenya: Government Press, 2018. Print.
Kidali, John A . "Appraisal of Animal Health Constraints Along the Dairy Value Chains in Kenya." *International Journal of Research Publications* 54.1 (2020): 8-8. Print.
Kidali, John A, et al. "Study on Appraisal of Animal Health Constraints Along the Dairy Value Chains in Kenya." *Current Topics in Agricultural Sciences* Vol. 2 (2021): 51-58. Print.
Kothari, C.R. *Research Methodology, Methods and Techniques*. (2 Revised). Ed. Publishers., Revised International New Delhi: New Age: Delhi: New, 2008. Print.
Mochabo, Kennedy Miyoro, et al. "Mapping of Livestock Value Chains as a Tool for Understanding Disease Risks in Agro-Pastoral Systems of Kajiado County, Kenya." (2022). Print.
Mohamed, Abdilatif H. "Analysis of Pastoralists' Perception on Challenges and Opportunities for Sheep and Goat Production in Northern Kenya." University of Nairobi, 2018. Print.
Mugenda, O Mugenda, and AG Mugenda, eds. *Research Methods: Quantitative and Qualitative. Approaches*. Nairobi: African Centre for Technology Studies, 2003. Print.
Onduso, Richard, et al. "Assessment of Structure and Performance of Cattle Markets in Western Kenya." *Tropical animal health* 52.2 (2020): 725-32. Print.
Reyes, J, et al. "A Multi-Institutional Approach to Implement Fruit Fly Low Prevalence and Free Areas in Central America: Outcomes and Constraints." (2005). Print.
Shanguhyia, Naomi. *State Policy and Food Insecurity in Kenya's Arid and Semi-Arid Land (Asal) Regions*. West Virginia University, 2008. Print.
Simon, PW Omondi, et al. "The Status of Livestock Technologies and Services in the Southern Maasai Rangelands of Kenya." *African Journal of Agricultural Research* 9.15 (2014): 1166-71. Print.
Statistics, IS %J Google Search. "Ibm Corp. Released 2013. Ibm Spss Statistics for Windows, Version 22.0. Armonk, Ny: Ibm Corp." (2013). Print.
Thomas, RJ, et al. "The Development of Integrated Crop-Livestock Production Systems in the Low Rainfall Areas of Mashreq and Maghreb." (2003): 97-110. Print.
Yilma, Zelalem, et al. "A Review of the Ethiopian Dairy Sector." 81 (2011). Print.