Climate Smart Research and Innovation for Livestock Development in Kenya with a focus on Dairying

Contact information:
David Butler
Director
Sustainable Food Systems Ireland,
The Plaza, East Point Business Park,
Dublin 3.
Ireland
Tel: +353-1-727-2886
Email: david.butler@sfsi.ie

1. IDENTIFICATION

Title	Climate Smart Research and Innovation for Livestock Development in Kenya with a focus on Dairying
Short Title	DairyKenya
Total cost	EUR ~€1M
Duration	30 months

2. RATIONALE

2.1 Background, context analysis and justification

Dairying is the single largest sub-sector in Kenyan agriculture, accounting for 6-8% of the country's GDP. The sector is characterised by low-input, low-yield systems, which produce much less than the national herd potential, with productivity per milking cow being low and highly variable, ranging from four to eight litres a day. Overall production in 2016 amounted to 4.1bn litres of milk and only about 55% of this milk is sold either in informal or formal markets. Around 80% is consumed as liquid milk.

Kenya is experiencing a growing demand for milk and dairy products driven by expanding urbanization, increasing population and a growing middle class. As a result, the country will need to significantly increase milk supply, especially to urban consumers. An additional 3.5bn litre per annum will be required by 2022 (versus 2012 output) and a target output of 12.5bn litres p.a. by 2030. To come near to achieving these targets, output per cow will need to double.

A key challenge to improved productivity in the dairy sector is climate change. The Kenyan Government has set ambitious targets in relation to Climate Smart Agriculture[1] (CSA), centred on adaptation and resilience; reduction of greenhouse gases; legal, policy and institutional strengthening; and addressing cross-cutting issues that affect CSA. The country's agriculture is predominantly rain-fed and, therefore, vulnerable to climate change, particularly changes in temperature regimes, precipitation patterns and extreme weather events. The country's greenhouse gas (GHG) emissions were estimated at 73 million tons of carbon dioxide equivalent (Mt CO_2 e) in 2010 and are expected to rise to 143 Mt CO_2 e in 2030 (96% increase) unless appropriate mitigation actions are taken. Agriculture is the largest source of GHG emissions; it was responsible for one-third of Kenya's total emissions in 2010.

Agricultural development initiatives in Kenya will, therefore, have to reconcile the conflict between growth of output and the requirement to reduce greenhouse gases. Much more focus is needed on developing innovations informed by research which can improve climate change adaptation and help mitigate greenhouse gas production by the livestock sector while addressing the country's ambition for growth in dairy sector output.

Kenya's Ministry of Agriculture, Livestock and Fisheries published a National Dairy Development Policy in 2013[2], which aims to develop an efficient, commercially competitive and self-sustaining dairy industry. The policy aims to improve dairy sector productivity, which in turn, will deliver national food security, increased incomes and economic growth. In addition to specific food security, competitiveness and improved livelihoods objectives, the policy also aims for an increase in Kenyan dairy exports and a re-orientation of processing towards long-life dairy products. This policy context remains relevant, even though the experience to date has not matched the ambitions. This project proposal aims to support national policy to create an efficient, competitive and self-sustaining sector.

Ireland's involvement in the agri-food sector in Kenya is governed by the bilateral Ireland-Kenya Agri-Food Strategy[3] (IKAFS), which is a multi-year plan developed by the Embassy of Ireland in association with Kenyan and Irish partners and launched in 2017. IKAFS identified three priority value chains for support, one of which is the dairy sector. It is

[1] Kenya Climate Smart Agriculture Strategy 2017-2026, Ministry of Agriculture, Livestock & Fisheries, 2017
[2] Towards a Competitive and Sustainable Dairy Industry for Economic Growth in the 21st Century and Beyond, Ministry of Agriculture, Livestock & Fisheries, 2013
[3] The Ireland/Kenya Agri-Food Strategy 2017-2021, Embassy of Ireland 2017

fully consistent with the Kenyan Government's plans for agricultural development as outlined in Vision 2030[4] and the Kenya Agriculture Development Strategy 2010-2020.

This proposal is submitted by **Teagasc**, the Irish agriculture and food development authority, in partnership with the **Kenya Agriculture and Livestock Research Organisation** (KALRO), the Kenyan national agriculture and livestock research and development organisation, and Teagasc partner **Greenfield International** (GI) a forage-based livestock systems specialist. The proposed project will also be supported in detailed design and implementation by **Sustainable Food Systems Ireland** (SFSI), the international consultancy group of Ireland's Department of Agriculture, Food and the Marine.

The resources sought under Embassy of Ireland funding will allow the applicants to build a dairy production systems initiative aimed at transforming the livestock sector and help build progress towards Sustainable Development Goals targets on poverty, hunger/food security, climate change and ecosystem development. A particular focus will be on the introduction of research-led innovations at the production level and along the value chain, which will allow the industry to grow in a climate-smart, sustainable way.

2.2 Thematic coordination and complementary actions

Whilst considerable progress has been made in value chain development post-farm gate in Kenya (milk assembly, input service sector, co-op development, finance sector, processing, product development and access to market), change within the farm gate has been stubbornly slow (especially on small and medium size farms) despite many interventions over the years. This presents a major challenge to Kenyan's ambition to grow the dairy sector.

This project will focus on dairy production at farm level and will build on existing initiatives underway in Kenya. It will also link with ongoing CGIAR livestock research (ILRI and ICRAF) in other parts of East Africa, specifically in Tanzania, Ethiopia and Eritrea. The project will also seek to provide important enablers for national policy goals in breeding, value addition and industry skills development. The project aims to link international research knowledge with local knowledge by building relationships between institutions in Africa and Europe with a view to increasing science in development and thereby achieving a profound transformation of the livestock sector in Kenya.

This project topic has been under discussion by project partners and key actors - farmers, processors, NGO's and partner institutions since 2018, including a two-day workshop held in Naivasha in March 2019. In project preparation discussions between partners, it became clear that dairy industry stakeholders agree that a paradigm shift is needed in the system of dairy production in Kenya. Currently, the sector depends on the importation of animals/genetics which are bred for high milk yields based on the feeding of high-quality concentrates. Given the quality of the feed resource in the Kenyan system, these imported animals perform poorly in terms of milk productivity; produce high levels of enteric methane production (due to a large number of low productivity animals); and provide low gross margin and poor farm profitability. There is clear evidence[5] that forage-based production systems in Kenya deliver better gross margins for farmers. There is also significant capacity for improved production, conservation and utilisation of forages in Kenya, as well as a potential benefit in resilience and adaptation.

From our discussions with Kenyan stakeholders, there is general agreement that new initiatives are needed in Kenya to transform the dairy sector at producer level so as to increase milk production in a profitable and sustainable way. Experience from national livestock development programmes in the EU tells us that the implementation of transformative, climate-smart innovations requires the input of user-driven research-based evidence. The traditional linear model of technology transfer needs to be replaced by an innovation model in which the farmer is a key player in the development and application of new CSA technologies on-farm. When successful, key innovations can lead to improved sustainability for producers, including women and men smallholder farmers and trigger enhanced economic activity along the agri-food value chain.

3. DESCRIPTION

Project Preparation: This project topic has been under discussion by project partners since mid-2018. A delegation from Ireland (Teagasc/SFSI) visited Kenya in late March 2019 to study the dairy value chain in Kenya and to meet with key actors - farmers, processors, NGO's, Kenyan institutions (KALRO) and International

[4] Kenya Vision 2030. Government of Kenya

[5] Kimenju S. 2016 Report on a study assessing the cost of production structures in dairy systems in Kenya, KDB; Tegemeo Institute of Agricultural Policy and Development, Egerton University

organisations (ILRI and ICRAF). A workshop was held in KALRO Naivasha (26th & 27th March 2019) to discuss the theory of change model.

Test the Hypotheses

"When there is a focus on selecting animals on their ability to optimize use of forage grown on-farm, milk output increases, on-farm costs are reduced, farm income increases, the abatement potential increases from genetic gains in production efficiency, resulting in reduced inputs per unit of farm produce."

"When there is a focus on involvement of farmers and other value chain actors in the innovation process, the adoption of new/improved practices increases resulting in more profitable and sustainable production on farm and value addition along the value chain."

3.1 Objectives

The goal of the project is to contribute to the knowledge and on-farm practice in the creation and implementation of innovative climate smart and economic production systems through the introduction of **forage-based animal genetics** and application and the use of **novel climate smart forage feeding systems on-farm**. To achieve the project's goal of developing climate smart production systems that increase productivity and reduce greenhouse gases in a sustainable way, three key capability-building sub-objectives will be pursued:

1. To develop a new **cattle breeding programme** with a focus on farm profitability through use of improved forages, which can mitigate emissions and improve resilience, including related capability-building in the national research system.
2. To develop and demonstrate new **improved systems of production** (forage based) which can meet 90%+ of the animal's dietary requirement from forage and which are resilient in terms of climate change.
3. To develop an **Innovation Hub** in support of the dairy value chain with a particular focus on innovation support on-farm and which can build capacity in forage-based production technology through existing extension networks and routes to lead farmers via external Innovation Nodes, located and facilitated by private sector processors, INGO's, co-operatives and producer groups, with a specific focus on inclusion of women and young farmers.

Capability-building activities will focus on:

- Economic modelling and breeding programme development for the national research body and relevant county governments.
- Train-the-trainers – training of extension agents and lead farmers in forage production systems, forage quality and animal nutrition, as well as in group extension methods.
- Innovation support – build a lasting system and capability in KALRO for innovation transfer, knowledge dissemination and packaging of research outcomes for optimum uptake by farmers.

The project's Theory of Change is that improved dairy farm systems - forage-based animal genetics and application and the use of climate smart forage feeding systems on-farm - will lead to better farm-level profitability, giving farmers at all stages of development an economic incentive to adopt and continue to use more economically and environmentally efficient farming practices. Improved income on dairy farms greatly helps the local rural economy (important for villages and small towns) as farms tend to spend their income locally.

Strengthening of the national applied research capability and institutional relationships between the partners will enable continuous improvement in a national dairy breeding programme and allow KALRO to provide leadership on genetic gain and sector competitiveness after the end of the project. This new capacity at KALRO will greatly strengthen the policy agenda for the sustainable development of the sector.

4. PROJECT ACTIVITIES

Project activities and work packages can be summarized in the following table.

Objective/Activity		Work Packages	
1	Development of a new dairy cattle breeding programme with a focus on genetics which can	1.1	Comparison of different breeds/strains of dairy cattle managed under a forage-based system

	exploit a forage-based system of production for maximum farm profitability.	1.2	Develop Economic Breeding Index (EBI) for Kenya
2	To develop and demonstrate new improved systems of production (forage based) which can meet 90%+ of the animal's dietary requirement from forage and which are resilient in terms of climate change.	2.1	Establishment of a demonstration forage-based production system
		2.2	Nutritional studies in support of forage-based dairy production systems
		2.3	Forage production and conservation strategies to meet needs of forage-based dairy production system
3	Establishment of an Innovation Hub at KALRO Naivasha	3.1	Support for the development of a KALRO Innovation Hub – an innovation support unit for the Kenyan dairy sector
		3.2	Develop and implement a capability-building programme for Extension agents and Lead Farmers providing Innovation Support on farms

4.1 Development of a new dairy cattle breeding programme for Kenya with a focus on genetics which can exploit a forage-based system of production for maximum farm profitability

Genetic improvement offers an opportunity to improve the efficiency of dairy value chains and can be realized by importation of exotic breeds or by local breeding programmes. Local breeding programmes for developing dairy cattle industries provide a means to address unfavourable genotype by environment (G x E) interactions resulting from importation of exotic germplasm[6]. Kenya has relied on the use of local breeding programmes to identify breeding bulls through a tedious and time-consuming progeny testing programme. Moreover, these local breeding programmes have been hampered by the lack of pedigree and performance recording plus other technical and infrastructural challenges[7]. This scenario has resulted in a significant number of dairy farmers opting to use proven genetics through importation of exotic dairy germplasm, mostly semen, embryos and live animals. While use of such imported germplasm would theoretically result in some genetic improvement, local breeding programmes for developing dairy cattle industries provide a means to address unfavourable genotype by environment (G x E) interactions resulting from importation of exotic germplasm[8]. Most of the imported germplasm has been selected based on breeding indices developed under high input systems (high quality forage and concentrate feeding) in temperate environments; the result of introducing such genetic material is detrimental G x E interactions resulting from differentials in production systems and environments, hence depressed performance in African context in the long run. An ideal situation would be to set up customized breeding programmes with economic selection indices that are based on suitable breeds/genotypes, as well as within practical feeding and husbandry support systems.

4.1.1 Work Plan – Dairy Cattle Breeding Programme

There are two aspects to the work plan:

1. Research and development component
2. Capability-building resulting from collaboration with Teagasc

The work plan will be described under a number of work packages.

Table 1 Work Package 1.1 Description

Work package number	1.1	**Start Date**	Month 1
		End Date	Month 30
Work Package Title	Comparison of different breeds/strains of dairy cattle managed under a forage-based system in Kenya		
Activity Type	Research and Capacity Building		
Participant Number	**01**	**02**	**03**
Participant Short Name	**KALRO**	**Teagasc**	**GI**
Objective The objective of this work package is to compare different breed/strains of dairy cattle under a forage-based system			

[6] J. Dairy Sci. 100:2258–2268: https://doi.org/10.3168/jds.2016-11816
[7] Wasike et al., 2011; Kosgey and Okeyo, 2007
[8] Ojango and Pollot, 2002; Kariuki et al., 2017

of milk production. In particular, the objective is to:

- Compare breeds/strains in terms of milk production and milk constituent yield and seasonality of yield.
- Effect of breed/strain of dairy cattle in terms of fertility parameters, liveweight change, lactation length, calving interval, calf birth weight, difficulty of calving and calf survival rate.
- Effect of breed/strain of dairy cattle in terms of feed intake at different periods during lactation (early, mid- and late lactation).

WP Leader: Dr Evans D. Ilatsia (KALRO)

Description of the work

Understanding the relationship between strain of Holstein-Friesian (HF) and environment is becoming increasingly important because cows are now managed in a diverse range of environments worldwide. Recent studies (mainly from temperate climates) have shown results on strain by environment interactions. Holstein Friesians from North America and Europe are now widely used in Kenya. Farmer experience with these breeds is disappointing even when these breeds are fed higher levels of concentrate feeding. In many situations local indigenous breeds are performing as well if not better under Kenyan production systems. This research will involve a comparison of different breeds/strains and breeds of dairy cattle managed in a production system where 90%+ of annual feed requirement comes from forage produced on-farm. The breeds and strains of dairy cattle to be compared are given in the Table below.

Breed/genotype	Rationale
Holstein Friesian	This has been the traditional dairy breed of choice of many farmers in the country (both small-medium scale and large-scale farms). Breed origin from high output: high input system of production.
Friesian x Sahiwal Cross	This will represent an intermediate breed line that combines the relatively high production levels of the Holstein and the adaptation and milk quality attributes of the Sahiwal. The genotype will reflect the crossbred population that supports dairy in medium to low potential areas
Sahiwal Breed	This breed is well adapted to Kenyan production environment and has good milk quality attributes. KALRO holds the herd book for this breed in Kenya

A fourth cohort of cattle will be introduced for future study through the importation of genetics from Ireland using AI straws to cross with domestically sourced Friesian heifers. Production data from this herd will not be available until Year 3 and subsequent years.

Irish black and white (Friesian)	This breed has been developed over the years with emphasis on fertility and survival traits under a forage-based feeding system. It will therefore be a reference breed in this breeding programme and based on lessons learnt and experience in Ireland, it will be used as a basis of comparison to the Kenyan scenario.

Tasks

Task 1.1.1 Establishment of project trial to compare breed/strains of dairy cattle **(M1-30):**
Leader: Dr Evans D. Ilatsia (KALRO)
Involved partners: KALRO, Teagasc and Greenfield International
Three milk production systems (using breeds as defined above) will be set up on the experimental farm at KALRO Naivasha. The experiments will be performed with herd sizes of 30 cows per treatment. The experimental treatments will be applied under this project over a 2-year period (initially). The data obtained in the experiment will be used in the farm systems model and economic assessments in WP 3 and 4 respectively.

Task 1.1.2 Preparation of a detailed protocol in relation to management of research herds **(M1-M2):**
Leader: Dr Evans D. Ilatsia (KALRO)
Involved partners: KALRO, Teagasc and Greenfield International
A protocol will need to be prepared which will outline how the experimental herds will be managed on an annual/multiannual basis for the treatments to be compared in Task 1.1 above.

Milestones (brief description and month of delivery)

M 1.1.1: Final decision in relation to number of breeds and strains of dairy cattle to be selected for the study (M1)
M 1.1.2: Detailed protocol for herd management available (M2)

Deliverables (brief description and month of delivery)

D 1.1.1: Two-year comparison of experimental breeds of animals completed (M 24).
D 1.1.2: Report prepared on the results of the breed comparison trial (M24).
D 1.1.3: Training courses delivered for extension agents (M12 and M24)

Table 2 Work Package 1.2 Description

Work package number	1.2	**Start Date**	Month 2
		End Date	Month 27
Work Package Title	Develop Economic Breeding Index (EBI) for Kenya		
Activity Type	Research /Development/Capability Building		
Participant Number	**01**	**02**	**03**
Participant Short Name	**KALRO**	**Teagasc**	**GI**

Objective
The objective of this work package is to develop an Economic Breeding index for dairy cattle in Kenya

WP Leader: Dr Evans D. Ilatsia (KALRO)
Description of the work
There are several perspectives which can be taken in deriving economic values (e.g. cost price minimisation, individual producers' profit). In this project, economic values will be derived from the individual producer's viewpoint, because producers are the major decision makers in the dairy industry. The perspective of individual producers will be profit maximisation. Furthermore, this project will be limited to the micro-economics of an individual farm. Following others[9], the total annual profit in Kenyan Shillings (KES /Year) of a dairy herd *(T)* can be described as follows:

$$T = N(R - C) - c_f$$

where c_f are the fixed costs of the farm, N is the number of lactating cows, R are the average revenues (KES per cow per year), and C are the average costs (KES per cow per year). A farm systems model will be developed (WP 2.1) which can simulate the effect of various physical and economic factors on farm profitability. Economic values will be derived by simulating genetic improvement *(dx)* for each breeding goal trait independently (probability of surviving to the next lactation, calving interval, milk, fat or protein yield), and comparing model output with the default scenario. Two different bases of evaluation will be assumed in this study:

(i) Payment systems on milk composition;
(ii) Payment system where milk payment is on a volume basis only.

Tasks

Task 1.2.1 Exposure and capability-building for KALRO breeding staff to bio-economic modelling systems and approaches (M2).
Leader: Dr Evans D. Ilatsia (KALRO)
Involved partners: KALRO, Teagasc and Greenfield International
A small KALRO team will visit Teagasc Moorepark to get an understanding of how the EBI was developed in Ireland. The team will also visit Irish Cattle Breeders Federation (ICBF) who have responsibility for managing the national breeding programmes in Ireland, including a national database.

Task 1.2.2 Establish the parameters (animal characteristics) for developing the economic breeding index **(M3-M4):**
Leader: Dr Evans D. Ilatsia (KALRO)
Involved partners: KALRO, Teagasc and Greenfield International
The parameters of importance in the Kenyan context (e.g. milk yield, calving interval, survival rate) to be established taking cognisance of data availability etc. (recording systems). It is likely that only a small number of traits will be used in the index initially.

Task 1.2.3 Establish the breeding values for the traits identified from Task 1 above **(M5-M24):**
Leader: Dr Evans D. Ilatsia (KALRO)

[9] R.F. Veerkamp *, P. Dillon, E. Kelly , A.R. Cromie , A.F. Groen (2002). Dairy cattle breeding objectives combining yield, survival and calving interval for pasture-based systems in Ireland under different milk quota scenarios.

Involved partners: KALRO, Teagasc and Greenfield International
Analysis of animal data base at KALRO and nationally so as to derive breeding values to be use in new Economic Breeding Index.

Task 1.2.4 Establish the economic values for the traits identified from Task 2.1 above **(M5-M24):**
Leader: Dr Evans D. Ilatsia (KALRO)
Involved partners: KALRO, Teagasc and Greenfield International
New Dairy Farm Systems Model (from WP 2.1) to be used to derive economic values for each of the traits identified from Task 2.1 above.

Tasks 1.2.5 Develop and launch first draft of new Economic Breeding Index (EBI) **(M25):**
Leader: Dr Evans D. Ilatsia (KALRO)
Involved partners: KALRO, Teagasc and Greenfield International
New Economic Breeding Index to be launched and tested using satellite commercial herds attached to KALRO Naivasha.

Tasks 1.2.6 Information on Economic Breeding Index and breeding information collated in a form to be used by KALRO Innovation Unit **(M26-M27):**
Leader: Dr Evans D. Ilatsia (KALRO)
Involved partners: KALRO, Teagasc and Greenfield International

Information will be collated and presented in a form which can be used by extension officers and farmers. Training on the use of the information will also be provided as part of the work of the Innovation Unit.

Milestones (brief description and month of delivery)
M 1.2.1 Terms of reference agreed for visit to Moorepark (M1)
M 1.2.2 Discussion with industry representatives re parameters to be used in breeding index. (M3)
M 1.2.3 Discussion with industry representatives re launch of new EBI for Kenya (M28)

Deliverables (brief description and month of delivery)

D 1.2.1: Visit report (M 2)
D 1.2.2: Parameters to be used in Economic Breeding Index identified and documented (M 4).
D 1.2.3: Breeding values estimated for traits of economic importance (M 24).
D 1.2.4: Economic values established for the traits identified from D 1.2.2 above (M 24).
D 1.2.5: Economic Breeding Index launched (M 30).
D 1.2.6: Information prepared on new breeding system made available in a form suitable for technology transfer (Innovation Unit) (M 30).

4.2 To develop and demonstrate new improved systems of production (forage based) which can meet 90%+ of the animal's dietary requirement from forage and which are resilient in terms of climate change.

In most African countries, ruminant livestock production is usually forage-based depending mainly on natural pastures which are insufficient to provide crude protein requirements for optimum rumen microbial growth and the host animal performance[10]. Consequently, the digestibility and intake of these feeds are low which results in poor animal growth and reproductive performances. Although farmers might invest in high genetic breeds, their production will be affected by the poor-quality feeds, hence the animals will not reach their full production potential. Farmers are discouraged from using concentrates due to high cost and low quality (as fed). They do not meet the nutritional requirement of the animals. Several forages have been recommended for dairy production systems in Kenya[11]. One of the most significant benefits of growing legumes with grasses is the improvement in overall forage quality and forage digestibility[12]. Significant improvements in forage biomass yield, quality, and livestock performance have been reported when

[10] Hidosa Denbela, 2017. Role of Legume Forage Meal Supplementation on Feed Intake, Weight Gain, Digestibility and Carcass Characteristics of Ruminant Livestock. *Global journal of science frontier research Vol. 17 Issue 4 2017*.

[11] Boonman J.G., 1993. East Africa's Grasses and Fodders, Their Ecology and Husbandry. Published by Kluwer Academic Publisher P.O. Box 17, 3300 A Dordrecht, The Netherlands. 341pp

[12] Ball, D.M., M.Collins, G.D. Lacefield, N.P. Martin, D.A. Mertens, K.E. Olson, D.H. Putnam, D.J. Undersander, and M.W. Wolf., 2001. Understanding Forage Quality. American Farm Bureau Federation Publication 1-01, Park Ridge, IL.

forages were intercropped with legumes and fodder shrubs[13,14]. The feed resources produced under smallholder dairy production systems include napier grass, forage sorghum, rhodes grass, and sweet potato vines[10,15,16]. A few farmers may produce lucerne, desmodium, calliandra, sesbania, leucaena, brachiaria, home-made concentrates and total mixed rations[17,18,19]. Other feed resources are crop by-products and crop-residues (stovers and straws).

There is a need to develop improved production systems based on forage so as to meet the requirements of dairy cows with different genetic potential for milk production.

4.2.1 Work Plan

The work plan will be described under a number of work packages.

Table 3 Work Package 2.1 Description

Work package number	2.1	**Start Date**	Month 1
		End Date	Month 30
Work Package Title	Establishment of a demonstration forage-based production system		
Activity Type	Innovation Support /Development/Capability Building		
Participant Number	**01**	**02**	**03**
Participant Short Name	**KALRO**	**Teagasc**	**GI**

Objective

The objective of this work package is to establish a forage-based production system which supplies 90%+ of the animals' feed requirement on an annual basis. In particular this work will:

1. Using KALRO Naivasha (agro-ecological zone) as an example, establish what crops and in what proportion they are required to meet the feed requirement of dairy cows on an annual /multi-annual basis.
2. Compare feeding system using 2 breed /strains of dairy cow.
3. Provide input /output data (physical and financial) for development of Dairy Farming Systems Model
4. Provide a demonstration farm on-site at KALRO Naivasha in support of the Innovation Unit.
5. Provide a learning environment for KALRO staff in relation to systems development and management.

WP Leader: Mr Stephen Mailu (KALRO)

Description of the work

The existing facilities at KALRO Naivasha (pictured) will be used for the systems trial. It is large enough to accommodate two breeds of cattle. It is small enough to represent a farming systems perspective which farmers and extension agents can identify with. A fixed area of land will be allocated to this unit and the crops to be selected will need to be realistic in terms of actual farming systems. Since this is a demonstration unit, the requirement of experiments in terms of experimental design etc. does not apply. The breeds suggested are listed below.

Breed/genotype	**Rationale**
Friesian x Sahiwal Cross	This will represent an intermediate breed line that combines the relatively high production levels of the Holstein Friesian and the adaptation and milk

[13] Holmann, F. and Lascano, C., 2004. Feeding systems with forage legumes to intensify dairy production in Latin America and the Caribbean. ILRI (International Livestock Research Institute), Nairobi.

[14] Kabirizi, J., Ziiwa, E., Mugerwa, S., JEAN Ndikumana, J., and Nanyennya, D.W., 2013. Dry season forages for improving dairy production in smallholder systems in Uganda. *Tropical Grasslands – Forrajes Tropicales, Volume 1, 212-214F*ebruary

[15] Orodho, A.B., 2006. The Role and Importance of Napier Grass in the Smallholder Dairy Industry in Kenya; Food and Agriculture Organization: Rome, Italy. p. 2011,

[16] Lukuyu, B., Gachuiri, C. K., Lukuyu, M.N., Lusweti, C. and Mwendia, S. (2012). Feeding dairy cattle in East Africa. East Africa Dairy Development Project, Nairobi, Kenya.

[17] Wambugu, C., Franzel, S., Cordero, J. & Stewart, J. (2006). Fodder shrubs for dairy farmers in East Africa: making extension decisions and putting them into practice. World Agroforestry Centre, Nairobi, Kenya; Oxford Forestry Institute, Oxford, U.K. 172 pp

[18] Muia, J.M.K., Kariuki, I.W., Kanegeni, N.N., Ngae, G.N., Kariuki, J.N., Muinga, R.W., Gachuiri, C.K. and Mbugua. P.N., 2014. Total mixed rations for dairy cattle in Murang'a County. Technical Manual for Dairy Extension workers and farmers. Kenya Agricultural Research Institute, Nairobi, Kenya. ISBN No. 978-9966-30-012-6.

[19] Njarui, D. M. G., Gichangi, E. M. Ghimire, S. R. and Muinga, R. W. (Eds) 2016. Climate Smart Brachiaria Grasses for Improving Livestock Production in East Africa–Kenya Experience. Proceedings of the workshop held in Naivasha, Kenya, 14 -15 September, 2016. Nairobi, Kenya.

	quality attributes of the Sahiwal. The genotype will reflect the crossbred population that supports dairy in medium to low potential areas.
Sahiwal Breed	This breed is well adapted to Kenyan production environment and has good milk quality attributes. KALRO holds the herd book for this breed in Kenya

Cropping Programme	**Rationale**
Sorghum Silage	The feeds to be used and the relative proportion of each feed will be guided by research results from other work packages.
Lucerne (Fresh and Hay)	
Rhodes grass	

Tasks

Task 2.1.1 Establishment of Demonstration Unit and protocol for managing this unit. **(M1-M3)**
Leader: Mr Stephen Mailu (KALRO)
Involved partners: KALRO, Teagasc and Greenfield International

Two herds (probably 4 cows per herd) within existing facility at KALRO. The feed area and cropping programme as well as the conservation strategy will be designed so as to meet the feed requirement of the cows (90%+ forage). A detailed protocol in relation to all aspects of the management and recording if this unit will be important as the data from this unit will be used to inform Dairy Farm Systems Model.

Regular reporting on performance of animals by farm system will be made available. The Innovation Unit of KALRO will also package the research outcomes for use in the extension and outreach activities of the project.

Task 2.1.2 Development of a Dairy Farming Systems Model which can simulate the physical and economic parameters of a dairy farm. **(M3-M30):**
Leader: Dr Evans D. Ilatsia and Mr Stephen Mailu (KALRO)
Involved partners: KALRO, Teagasc and Greenfield International

Initially a review of systems available internationally will be carried out to select the most appropriate model to be developed /modified for the Kenyan system. Data from the farm systems work at KALRO together with other data sources will be then used to populate the model chosen. The Moorepark farm systems model can be modified for different production environments and may be appropriate for modification to reflect the Kenyan system of production.

Task 2.1.3 To use the Dairy Farming Systems Model from 2.1.2 above to simulate potential technology adoption rates, ex-ante impact assessment, and ecosystem services analysis **(M4-M6 & M24-M26):**
Leader: Mr Stephen Mailu
Involved partners: KALRO, Teagasc and Greenfield International

An ex-ante analysis providing the project with projections of impacts including the GHG emission intensities from different production systems is desirable. For instance, the extensive systems, are characterized by low milk production per cow, poor feed quality, poor reproductive performance (age at first calving at 4 years) and higher mortality rates. Some of the leading candidates for reducing emission intensity include production of improved forages, use of biodigesters and improving the management of grazing for extensive systems[20]. Though having a high technical mitigation potential, adoption is hampered by barriers such as costs and poor information in the absence of public and private sector incentives to catalyze change. The Trade-off Analysis for Multi-Dimensional Impact Assessment (TOA-MD) model[21, 22] will be deployed to perform ex-ante quantitative assessments of economic, environmental and social impacts associated with the adoption of the technology components (both breeding and feeding) envisaged from the project.

Milestones (brief description and month of delivery)

M 2.1.1: Final decision in relation to establishment of Demonstration Farm. (M1)

[20] Ericksen, P. and Crane, T. 2018. The feasibility of low emissions development interventions for the East African livestock sector: Lessons from Kenya and Ethiopia. ILRI Research Report 46. Nairobi, Kenya: International Livestock Research Institute (ILRI).
[21] Antle J.M. 2011. Parsimonious multi-dimensional impact assessment, *American Journal of Agricultural Economics* 93(5): 1292–1311
[22] Mulwa R, Rao KPC, Gummadi S, Kilavi M 2016. Impacts of climate change on agricultural household welfare in Kenya. *Climate Research* 67:87-97

M 2.1.2: Final decision in relation to the cropping programme to be used (M2)
M 2.1.2: Final decision in relation which model is most suited for the Kenyan production system. (M12)

Deliverables (brief description and month of delivery)

D 2.1.1: Protocol for managing herds in farm systems farm agreed and delivered (M2).
D 2.1.2: Report on performance of animals on Farm Systems Farm available (M12 and M24).
D 2.1.3: Farm Systems Model developed (M30).
D 2.1.4: Information from Demonstration Farm available to provide data for EBI (M12).
D 2.1.5: Information from Demonstration Farm packaged for use by KALRO Innovation Unit (M12 and M24).

Table 4 Work Package 2.2 Description

Work package number	2.2	**Start Date**	Month 1
		End Date	Month 30
Work Package Title	Nutritional studies in support of forage-based dairy production systems		
Activity Type	Research		
Participant Number	**01**	**02**	**03**
Participant Short Name	**KALRO**	**Teagasc**	**GI**

Objective

1. To develop appropriate forage-based diets for milk production of various dairy breeds
2. To develop appropriate forage-based diets for growth of young stock of various dairy breeds

WP Leader: Dr John Muia (KALRO)
Description of the work

Experimental animals
Lactating cows and young stock (calves and heifers) for the feeding trials will be selected from the breeding dairy herd at DRI. During the feeding trials three dairy breeds (Holstein Friesian, Friesian/Sahiwal cross and Sahiwal) will be compared while three classes of dairy cattle (Lactating cows, heifers and calves) will be studied independently per breed. Selection of milking cows will be based on stage of lactation (1-120 days in lactation) with highest response on feeding, parity (> 1 lactation), and live-weight. However, selection of young stock will depend on age and liveweight.

Experimental diets
Three basal forages (Napier grass, Rhodes hay, and forage Sorghum silage) and four supplements (Lucerne, green leaf Desmodium, Sweet potato vines, and concentrates) will be compared. Napier will serve as the control of basal forages while the concentrate will serve as the control of forage supplements. All forages will be grown as pure stand other than Napier/ Desmodium intercrop whereas Sorghum will be ensiled with forage supplements. The diets will be formulated to satisfy nutrient requirements for maintenance and target performance (growth rate and milk yield) of experimental animals. Energy sources and mineral salts will be included to balance for nutrient requirements when necessary. All basal forages will be tested among breeds per year, but different forage supplements will be replaced in the first three years.

Experimental Design
A Latin square experimental design with four replicates will be employed for all classes of dairy stock. The feeding trial for dairy cows will run for 18 weeks each year while the calves and young stock will be monitored for growth rates.

Tasks

Task 2.2.1 Preparation of a detailed feeding protocol **(M1-M2):**
Leader: Dr Paul Leparmarai (KALRO)
Involved partners: KALRO, Teagasc and Greenfield International

Detailed feeding protocols in relation to feeding trials and herd management will be developed so as to inform the Dairy Farm Systems Model.

Task 2.2.2 Develop appropriate forage-based diets for milk production for various dairy breeds **(M24-M30):**
Leader: Dr Paul Leparmarai (KALRO)
Involved partners: KALRO, Teagasc and Greenfield International

Dairy cattle forage rations comprising of protein source (30% of ration) and energy (70% of ration) will be

developed for milking herds. Milk yield and quality will be measured throughout the experimental period.

Task 2.2.3 Develop appropriate forage-based diets for growth of young stock of various dairy breeds **(M24-M30):**
Leader: Dr Tobias Onyango (KALRO)
Involved partners: KALRO, Teagasc and Greenfield International

Forage rations for young stock (calves and heifers) comprising of protein (30% of ration) and energy (70% of ration) will be developed. Body weight and feed intake will be recorded throughout the experimental period.

Task 2.2.4 Determine feed and milk quality from the experimental trials **(M6, M12, M18 & M24):**
Leader: Dr John Muia (KALRO)
Involved partners: KALRO, Teagasc and Greenfield International

Feeds and milk samples will be analysed for chemical composition throughout the experimentation period to determine changes in milk quality.

Milestones (brief description and month of delivery)
M 2.2.1: Detailed feeding protocol availed (M2)
M 2.2.2: Feeding on forage-based diets implemented for dairy breeds (M30)
M 2.2.3: Feeding on forage-based diets implemented for young stock (M30)
M 2.2.4: Number of samples analysed

Deliverables (brief description and month of delivery)

D 2.2.1 Experiment put in place at KALRO DRI (M3).
D 2.2.2 Report on performance of experimental animals (M12 & M24).
D 2.2.3 Provide practical feed formulation tools for use by extension staff and farmers (M12)
D 2.2.4 Draft Research Report available (M24).
D 2.2.5 Information of nutrition options collated and made available for Innovation Unit (M12).

Table 5 Work Package 2.3 Description

Work package number	2.3	**Start Date**	Month 1
		End Date	Month 26
Work Package Title	Forage production and conservation strategies to meet needs of forage-based dairy production system		
Activity Type	Research and Development		
Participant Number	**01**	**02**	**03**
Participant Short Name	**KALRO**	**Teagasc**	**GI**

Objective
Using a farming systems perspective, the objective is to generate information on production and conservation of a number of forages which can be used as a basal forage feed resource and which can provide for supplementation at key periods during lactation.

WP Leader: Mr William Ayako (KALRO)
Description of the work

Preparation of forage programme for farm breed comparison
Approximately 75 ha of land will be set aside for the planting of forages based on potential forage yields, number of animals and their requirements. The land will be fenced to avoid grazing by animals from the outside. Land preparation and planting will be done four months in advance to the beginning of the experiment so that the forages will have enough time to establish.

Forages will be harvested several times a year and fed to animals at the right stage of maturity when they can provide the required nutrients to the animals. The forage budget will be planned so that there will be availability of forages the whole year. Ensiling and hay making are the main forage conservation methods by farmers. Hay from Rhodes and Naivasha star grass will be baled, and sorghum/Lucerne will be ensiled to conserve and to supplement the animals during the dry season.
The suggested feed types are given in the table below.

Forage	Feed type	Justification	Method of feeding
Lucerne	Supplement	High protein feed, ideal conditions for growing in Naivasha	Fed fresh, hay and silage
Rhodes grass	Basal	Widely adapted grass, fast establishment and drought tolerant.	Hay
Napier grass	Basal	Most popular forage among smallholder farmers, good intercrop with legumes and high yielding	Fed fresh
Naivasha star grass	Basal	Adapted to most soils and climate. Tolerant to grazing and requires low rainfall	Free grazing
Green leaf	Supplement	High protein feed and easily intercropped with Napier	Fed fresh and silage
Sweet potato vines	Supplement	High protein feed, rapid establishment and suitable in different soil types	Fed fresh
Sorghum	Basal	Ideal for silage making and it's not prone to diseases	Silage

Tasks

Task 2.3.1 Preparation of a detailed forage production protocol **(M1-M2):**
Leader: Dr Tobias Onyango (KALRO)
Involved partners: KALRO, Teagasc and Greenfield International

A detailed protocol in relation to forage production will be important as the data from this unit will be used to inform Dairy Farm Systems Model.

Task 2.3.2 Development of feed budgets **(M1):**
Leader: Dr Paul Leparmarai (KALRO)
Involved partners: KALRO, Teagasc and Greenfield International

Within the first month, a feed budget will be developed to support the feeding of experimental animals throughout the study period. The feed area and forage production plan as well as the conservation will be designed so as to meet the feed requirement of the cows (90%+ forage).

Task 2.3.3 Establishment of basal and supplementary forages (**M1, M12 & M24):**
Leader: Mr William Ayako (KALRO)
Involved partners: KALRO, Teagasc and Greenfield International

Based on the feed budget above, both basal and supplementary forages will be planted at different times of the project period. The forages in question are as summarized above.

Task 2.3.4 Determination of forage biomass yields and related production costs **(M8, M14, M20 & M26):**
Leader: Mr Stephen Mailu (KALRO)
Involved partners: KALRO, Teagasc and Greenfield International

Regular recording and monitoring of biomass yield of the forages will be determined to ascertain forage growth and seasonal changes. Associated costs of production of the different forages will be used for gross margin analysis.

Task 2.3.5 Conservation of forages **(M12, M18 & M24):**
Leader: Mr William Ayako (KALRO)
Involved partners: KALRO, Teagasc and Greenfield International

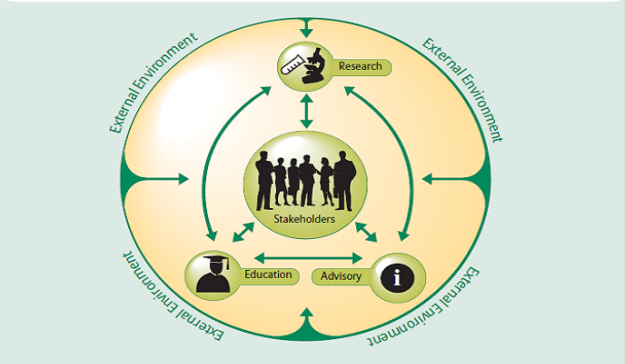
Surplus forages will be harvested at the right stage of growth for hay making and ensiling so as to optimize yield and quality in context of meeting the dairy cow's nutrient requirement. The quality of the conserved forages will be monitored through laboratory analysis.

Task 2.3.6 To monitor forage quality and quantity **(M6, M12, M18 & M24):**
Leader: Dr John Muia
Involved partners: KALRO, Teagasc and Greenfield International

The quality of the forages will be monitored continuously to ensure that the forages fed to the animals have the adequate amounts of nutrients to meet the animal's requirements. A detailed protocol in relation to forage production will be important as the data from this unit will be used to inform Dairy Farm Systems Model.

Milestones (brief description and month of delivery) **M 2.3.1**: Detailed forage production protocol availed (M2) **M 2.3.2**: Feed budget developed (M1) **M 2.3.3**: Hectares forages established (M24) **M 2.3.4**: Forage biomass yields, and production costs determined (M26) **M 2.3.5**: Tonnes of conserved feeds (M24) **M 2.3.6**: Forage biomass and samples analysed (M24)
Deliverables (brief description and month of delivery) **D 2.3.1**: Protocol for forage production (M2) **D 2.3.2**: Annual feed budget (M1, M12, M24) **D 2.3.3**: Four basal and three supplementary forages established **D 2.3.4**: Report of forage biomass yields and production costs **D 2.3.5**: Quantities conserved **D 2.3.6**: Number of feed samples tested

4.3 Establishment of an Innovation Hub at KALRO Naivasha



The Teagasc Model of Innovation

An effective Agriculture Knowledge and Innovation System (AKIS) is generally accepted to embrace an integrated system involving agricultural research, education/training and extension components with stakeholders at its core. A schematic representation of the Irish system is shown in this figure (The Teagasc Model of Innovation). This diagram depicts the relationship between the "actors" that are involved in the core of the system (Teagasc is the lead provider in the Irish system) and the "external" knowledge innovation system. The external system is multifaceted, embracing both national and international dimensions, and includes private research entities, private agricultural consultants and veterinarians, food processing companies and cooperatives, input supply and service companies (e.g. finance and ICT), universities and institutes of technology, the Ministry of Agriculture, Food and the Marine and other government departments and public agencies. Ireland is almost unique in having a substantial component of the AKIS within a single organisation, namely Teagasc. This, in principle, should lead to a more effective system.

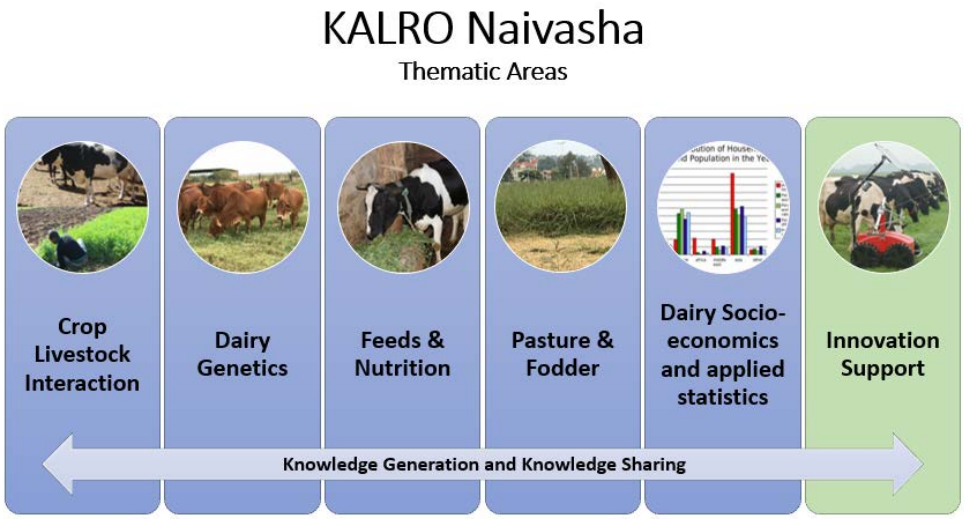
For this efficiency to materialise, it is crucial that there is an open flow of knowledge information between all elements of the system. There are several distinct information flows, namely: between the research, education/training and advisory/extension components; the flows between stakeholders and these components; and the flows between externally available information and the "internal" system. The components of the "internal" system need to be best in class with a persistent emphasis on innovation. The Extension component has evolved significantly over recent years from an emphasis on the imparting of knowledge to farmers to a focus on supporting farmers, particularly through the facilitation of peer-to-peer learning. The primary vehicle (in the Irish context) for this shift in emphasis has been the establishment of Discussion Groups (DGs). These programmes could be considered as classic examples of "nudge" measures in that they provide a relatively gentle incentive to farmers to adopt technology through the medium of peer-to-peer learning.

The failure of knowledge systems to support/facilitate the adoption of research-based technologies is a common problem in many countries. Kenya has the potential to dramatically improve its performance in this regard. It has the components of an effective Agricultural Knowledge and Innovation System (AKIS) in terms of research capability and extension services. It also has a supportive policy environment. However, the linkages between research and other components of the AKIS are dysfunctional. There is a need to build a professional dedicated technology transfer capacity at research centres with a mandate and

resources to work with the extension service and the training institutes to improve adoption outcomes on farms.

A change in management structure is suggested for KALRO Naivasha to integrate the new responsibility of Innovation Support. An additional thematic area (Innovation Support) is suggested in addition to the five thematic areas currently at KALRO Naivasha.

Figure 1: KALRO Naivasha Thematic Areas



This will require the assignment or recruitment of staff led by an Innovation Manager, specialising in knowledge transfer and without a research function, who can utilise the research outcomes produced and the expert knowledge of the research officers to generate increased productivity and income on-farms. Research officers should assign some of their time to innovation support. It is proposed to establish an Innovation Support unit at KALRO Naivasha with a focus on getting new knowledge associated with this dairy project as well as existing knowledge applied on farm. This function will expand KALRO's current knowledge management and information communication activities, with a specific focus on the dairy sector and a workplan with substantial processor and farmer direct interactions.

Some key parameters associated with development of the innovation dissemination function are given in Appendix 1. Best practice internationally would suggest that these are important in order to effectively integrate innovation support with a research environment. The key functions of an effective comprehensive dairy extension system are given in Appendix 2.

It is proposed that KALRO Naivasha Innovation Unit will link with farmers through project partners (who represent key industry stakeholders) in providing innovation support to farmers. This service will be provided in collaboration with County Government extension services. This model is illustrated in Table 6 and Figure 2 below. The project team will build on preparatory work to agree partner "Nodes" – dairy processing co-operatives and private sector with existing extension activities and networks of lead farmers or potential to develop those networks quickly.

The partner "Nodes" will be encouraged to develop and use their networks of lead farmers and existing outreach programmes. The project activities will include capability-building modules delivered by the project to Node extension staff, county extension agents and lead farmers, who will in turn be supported to organize group demonstration and discussion activities on their farms with groups of 10 to 20 peer farmers from their communities. The support to the Nodes will be principally delivered by externally sourced Extension Specialists and existing KALRO staff under the Innovation Manager's supervision. The Innovation Manager will also be directly involved in delivery and interacting with lead farmers. At an

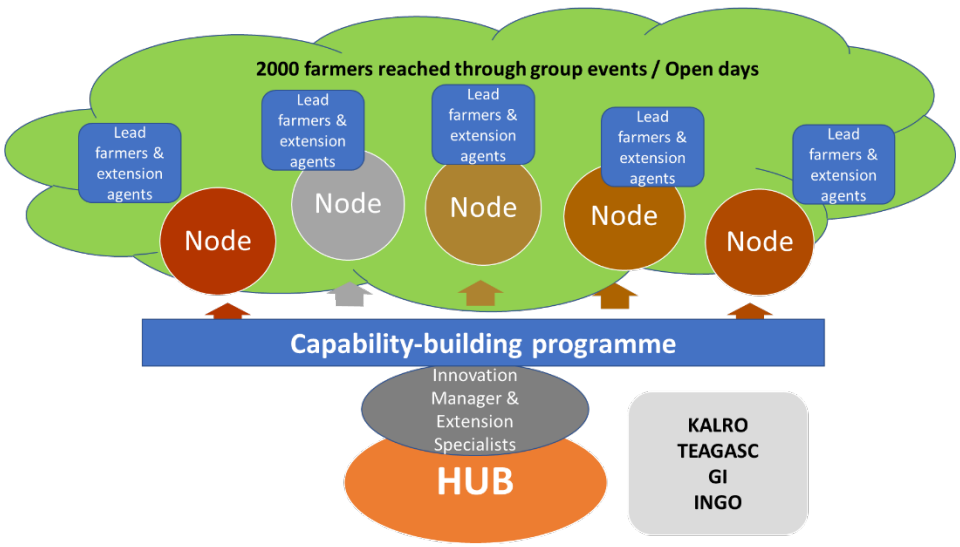
early stage, the Innovation Manager will define the location of specific activities under the innovation stream to include women and young farmers.

In project preparation, discussions with a number of co-operatives, Kenya-based NGOs and Brookside led to the development of the innovation hub and node concept. Meetings with co-operatives including Wakulima, Keringet and Githunguri; INGOs like Kenya Markets Trust, Solidaridad, Technoserve and Self-Help Africa; private sector including Brookside and Tetra Pak confirmed strong interest in principle in linking with the project and enabling access to their extension and lead farmer networks. An outline of potential participants is in Table 6, and a schematic of the outreach process in Figure 2.

Table 6 Innovation Support across Dairy Processor or Service Provider

Dairy Processor or Service Provider - Examples	**KALRO Naivasha Innovation Centre**	⟷	**County Extension Service**
Brookside Farm Support Service			
Mukurweini Wakulima Dairy Ltd			
Solidaridad-associate Dairy Hubs			
Githunguri Dairy Farmers Co-operative			
Keringet Dairies			
Pamojo Development			

Figure 2 Project Outreach



4.3.1 Work Plan

The work plan is described under the following work packages.

Table 7 Work Package 3.1 Description

Work package number	3.1	**Start Date**	Month 1

		End Date	Month 30
Work Package Title	Support for the development of a KALRO Innovation Hub – an innovation support unit for the Kenyan dairy sector		
Activity Type	Innovation Support and Capability Building		
Participant Number	**01**	**02**	**03**
Participant Short Name	**KALRO**	**Teagasc**	**GI**

Objective:
To develop an innovation support capacity at KALRO Naivasha which will link with innovation nodes managed by milk processors and service providers to farmers.

WP Leader: Innovation Manager (TBD, KALRO)
Description of the work
To develop an '**Innovation Hub**' in support of the dairy value chain with a particular focus on innovation support on-farm and which can build capacity in forage-based production technology through existing extension networks and routes to lead farmers via external Innovation Nodes, located and facilitated by private sector processors, INGO's, co-operatives and producer groups, with a specific focus on inclusion of women and young farmers.

Tasks

Task 3.1.1 Establish an innovation support unit at KALRO Naivasha **(M6):**
Leader: Mr David Mbugua (KALRO)
Involved partners: KALRO, Teagasc and Greenfield International

An innovation support hub linking other partners will be established at KALRO Naivasha responsible for easy coordination of technology dissemination activities. This will probably involve a change in the management structure at KALRO Naivasha. The issues outlined in Appendix 1 will guide this process.

Task 3.1.2 Develop linkages between Innovation Hub at KALRO Naivasha and potential Innovation Nodes (five) managed by a project partners including number of milk processors and service providers located in different regions/districts. **(M1-M3):**
Leader: Dr Tobias Onyango (KALRO)
Involved partners: KALRO, Teagasc, INGOs, Brookside and Greenfield International

Linkages between five Nodes will be coordinated from KALRO Naivasha building upon the linkages made in the project preparation. Agreements to co-operate with Nodes will be completed by M3.

Milestones (brief description and month of delivery)

M 3.1.1: Plan for innovation hub an KALRO Naivasha agreed (M1)
M 3.1.2: Finalisation of Innovation Node partnerships (M3)
M 3.1.2: First activities with Innovation Nodes underway (M6)

Deliverables (brief description and month of delivery)

D 3.1.1: Functional Innovation Hub established (M6 - M9)
D 3.1.2: Number of partnerships established with live activities underway (M6 - M27)

Table 8 Work Package 3.2 Description

Work package number	3.2	**Start Date**	Month 3
		End Date	Month 30
Work Package Title	Develop and implement a training programme for extension agents and lead farmers providing Innovation Support on farms		
Activity Type	Innovation Support/Capability Building		
Participant Number	**01**	**02**	**03**
Participant Short Name	**KALRO**	**Teagasc**	**GI**

Objective:
To provide capability-building to extension staff and lead farmers in relation to modern methods of innovation support on-farm and disseminating project outcomes.

WP Leader: Innovation Manager (TBD, KALRO)

Description of the work

Developing the skills of agricultural extension workers and lead farmers is an integral part of the overall agricultural production process. It is the responsibility of agricultural extension agents to reach farmers scattered around the country with useful and practical information in support of innovation for increased agricultural production. Lead farmers, identified through the project partnership links with NGOs and dairy co-operatives, will also be provided training. Skills needs will be assessed using the Borich Needs Assessment Model. This model is designed around the skills individuals and groups need to be effective in the future and are used for making human resources decisions. The focus of this work will be on influencing, upskilling and supporting the key people who will be responsible for on-farm innovation support as part of the project. Inclusion criteria to ensure impact for women and young farmers will also be developed. It is envisaged that resources supported by this project will spend a significant proportion of their time actively working with these intermediaries and with farmers. In order to meet the overall project target of engaging 2000 farmers, the project will create a schedule of capability-building for five Innovation Nodes, each with their own extension agents, county government staff and lead farmers. In turn, the project will support the lead farmers to create group activities on their own farms through availability of advice from core project extension staff and through small financial support for catering at group events. Two large Open Day events will also be organised at Naivasha.

Tasks

Task 3.2.1: Undertake a Needs Analysis for external extension network (M3)
Leader: Mr David Mbugua
Involved partners: KALRO, Teagasc, INGO, Brookside, County Government(s) and Greenfield International

Task 3.2.2: Design a capability-building programme and ongoing support for extension agents and lead farmers in developing group activities (M4)
Leader: Mr David Mbugua
Involved partners: KALRO, Teagasc, INGO and Greenfield International

Task 3.2.3: Capability-building programme implementation (M5-M30)
Leader: Mr David Mbugua
Involved partners: KALRO, Teagasc, INGOs, Brookside, County Government(s) and Greenfield International

Milestones (brief description and month of delivery)

M 3.2.1: Training curriculum developed (M4)
M 3.2.2: First training materials developed (M6)
M 3.2.3: First demonstration or Open Day (M7)

Deliverables (brief description and month of delivery)

D 3.2.1: Number of training materials developed (M20 - M25)
D 3.2.2: Training curriculum developed and delivered (M25 - M26)
D 3.2.3: At least 2000 farmers benefit directly from group events and Open Days (M30)
D 3.2.4: Monitoring and Evaluation report (M30)

5. EXPECTED RESULTS AND MAIN ACTIVITIES

The expected results and outcomes as well as expected Outputs and Activities are given in Table 9. The stakeholders listed in Section 8 below will comprise a Steering Committee which will oversee the implementation of the project.

Table 9: Summary Intervention Logic Table for Dairy Project Kenya

ULTIMATE OUTCOMES	Increased offtake of high value livestock (dairy) products from production systems which are climate smart, profitable and sustainable and which contribute to improved gender equitable income and livelihoods for smallholder farmers through a focus on the use of transformative forage-based production systems and where the type of genetics used is designed for forage-based systems.		
	↑		
INTERMEDIATE OUTCOMES	A paradigm shift towards the use of low-cost climate smart and resilient forage production systems where the type of cow genetics used can meet 90%+ of its nutrient requirements from forage. Novel knowledge sharing systems employed in support of innovations on-farm to increase milk production profitably and which are sustainable and inclusive in the longer term.		
	↑	↑	↑
IMMEDIATE	1. New animal breeding index	2. Improved forage production	3. Development of an Innovation

OUTCOMES	(EBI) developed for Kenya where the focus is on farm profitability and sustainability rather than on milk output per cow which contribute within the target areas to more competitive, sustainable and equitable dairy value chains.	systems developed which can meet 90%+ of the nutrient requirements of a dairy cow and which have built in adequate feed reserves (by conservation) which can respond to climate shocks in terms of feed supply.	Hub within KALRO and five corresponding Innovation Nodes at partner field sites to optimise access to farmers; the innovation network will focus on inclusive innovation support in context of climate smart agriculture.
	↑	↑	↑
OUTPUTS	1.1 New research data (technical and economic) generated through comparison of three different breeds/strains of dairy cattle under a forage-based production system in Kenya. 1.2 A bio-economic farm model which can derive economic values for traits of importance in development of breeding index. 1.3 Economic breeding index developed for ranking animals in terms of profitability and resilience rather than on production. 1.4 Recommendations in relation to breeding objectives available to policy makers, breeding organisations and farmers.	2.1 Novel Climate Smart forage feeding systems developed which can meet 90%+ of the animal's nutrient requirement. 2.2 Menu of forage feeding systems developed to meet requirements of different ecological zones. 2.3 Farm systems model developed which can assess farm system in terms of economics, biological and environmental indicators. 2.4 Demo farm established on KALRO site to demonstrate best practice in terms of Climate Smart profitable milk production. 2.5 Demo farm model extended out to Innovation Nodes and outreach/lead farms.	3.1 Innovation Hub established at KALRO site with five Innovation Nodes established at partner sites. 3.2 Steering Committee established to guide research and development agenda. 3.3 Decision support 'tools' available for use on-farm. 3.4 Training materials available and training provided through a capability development programme. 3.5 Innovation Nodes established to support lead farmers and group knowledge exchange, using existing pathways to farmers. 3.6 Two large scale Open Days at DRI Naivasha organized and delivered. 3.7 2,000 farmers benefit from participation and exposure through extension networks – five processor/co-operative Hubs x approx. 10 lead farmers each x 40 farmers each.

6. GEOGRAPHIC FOCUS

The project will be centred at the KALRO Dairy Research Institute, Naivasha, Kenya and on Innovation Nodes to be established on existing sites managed by private dairy processors, co-operatives and INGO's (at least five Innovation Nodes). The geographic focus of the project will be determined by the locations of the Nodes, and it is proposed that selection and finalisation of agreements with five Nodes be an early milestone under Work Package 3.1 (by Month 3). The preparatory stages examined potential partners in Nyeri, Kiambu and Nakuru Counties, as well as national players.

The project's focus will be on Kenyan dairy systems, but results will have applicability to other parts of East Africa, including Ethiopia, Eritrea and Tanzania. International Research Centres ILRI and ICRAF will be engaged in the detailed discussion of work programmes and invited to join the project Steering Committee. Their presence will help to enable the wider application of research outcomes and complementarity with their existing capabilities in the project themes. Opportunities for building on the research activities of this project including the participation of ILRI and ICRAF in future collaborative research will be pursued.

7. STAKEHOLDERS

End beneficiaries of the action will be Kenyan farmers, producer groups, co-operatives, private sector processors. Immediate beneficiaries will be the national research system, capability and infrastructure (KALRO), County Governments and a close network of partners where Innovation Nodes will be located.

It is critical that the project reach and support as many smallholder farmers as possible. This target will be pursued through outreach and demonstration activities, which will focus on interactions through Innovation Nodes established as described in Section 4.3. The Innovation Nodes will be at co-operative or processor run dairy centres and will be the locations for the delivery of train-the-trainer work with lead farmers and extension agents. In turn, the Nodes will support lead farmers to be first adopters of improved on-farm forage production and on-farm applied research. Lead farmers will be supported to organise group discussion and demonstration events, with each engaging with up to 40 farmers over the

project. The project recognises that farmers are a key component of development and application of new innovations on-farm. In aggregate, the project will engage 2,000 farmers in knowledge exchange actions. To disseminate research outcomes, the innovation strategy of the project will also develop a range of materials and knowledge exchange collateral, including published guides and easy-to-use online material for the use of all parts of the value chain.

Project implementation partners will be:

- **KALRO** – Kenya Agriculture and Livestock Research Organisation – KALRO's mandate is to undertake, streamline, coordinate and regulate all aspects of research in agriculture and livestock development, and promote the application of the research findings, technologies and innovations. KALRO will be at the centre of the applied research activities and support the outreach and private sector participation.
- **Teagasc** and **SFSI** - the agriculture and food development authority in Ireland. Its mission is to support science-based innovation in the agri-food sector and the broader bio-economy that will underpin profitability, competitiveness and sustainability. Teagasc will provide and oversee the application of technical expertise at all stages of the project. SFSI, the international consultancy division of Ireland's Ministry of Agriculture, Food and the Marine, will participate in a project management support role.
- **Greenfield International (GI)** - expertise in forage-based systems of production and their application on-farm, combined with substantial experience of capability-building in African agriculture.
- **International NGO** – on the ground project management and operations, project administration and backstopping, and support of the outreach activities.

A wider array of partners will be engaged through project activities:

- Kenyan private sector – **Brookside**, a large dairy processor will participate in and contribute to the research and extension elements of the project, as well as collaborating with KALRO on its dairy processing roadmap. **Dairy Africa** is a private sector integrator with extensive experience in dairy.
- **County Government(s)** – a number of County administrations, to incorporate their extension staff and take advantage of group activities with farmers.
- International Centres **International Livestock Research Institute** (ILRI) and **World Agroforestry** (ICRAF) both of which have centres in Nairobi.
- **Co-operative, Producer Groups and Service Providers** – one or more well-established and functioning groups, improving the project's relevance to farmers and its outreach and pilot fodder activities.
- International agriculture research organisations **ILRI** and **ICRAF** bring animal genetics and agronomy expertise.
- Irish private sector – companies like **Dovea Genetics** and **Nutribio** who have been active or interested in the Kenyan market will be included in opportunities to interact with project activities and build new relationships in the market.

The Lead Partner (Teagasc, Ireland) is associated with two complementary skills which can transform the knowledge-generation and knowledge-application systems in Kenya:

- Teagasc has an in-depth knowledge and experience of cattle production systems and their impact on farm profitability, value chain addition and the environment.
- Teagasc is actively involved in research and development projects (within country and EU funded[23,24] projects) on sustainable cattle production systems with a particular focus on livestock farming techniques, macro and micro-economics, farm system modelling and bioinformatics, GHG emissions and other environmental issues (ammonia, water quality, biodiversity).

The project will build upon, strengthen and extend the activities and lessons learned from past and ongoing development and climate smart projects in Europe (including Ireland), international centres (ILRI and ICRAF) and in Kenya and other relevant projects. Specific previous research relevant to this proposal include the ILRI-led African Dairy Genetics Gain Programme, which developed and tested a multi-country genetic gains platform that uses on-farm performance information and basic genomic data to strengthen dairy breeding in East Africa. This project would build on ADGG by using data and digital systems for data exchange previously developed. It will also collaborate with current ILRI work on dairy genomics at the Centre for Tropical Livestock and Genetic Health laboratory facilities in Nairobi.

[23] INTERREG Atlantic Area (No.304/216)
[24] LIFE 14 CCM/FR/001125

In Ireland, **Teagasc** has led substantial applied research into dairy farming systems, marginal abatement cost modelling, breeding management and genetic improvement of cattle, including multi-breed genomic selection and has played a major part in the transformation of the dairy industry into a profitable and sustainable export sector. It is also unique internationally in having research, innovation support and extension in one national organisation.

The proposed project will interact closely with other key research and regulatory organisations in Kenya such as the Kenya Agricultural Genetics Research Centre (KAGRC), Kenya Dairy Board, and Kenya Plant Health Inspectorate Service (KEPHIS). The existing regulatory and public service environment will also be considered in detailed design of project activities, for instance standards around milk quality and composition.

The project's partnership with dairy co-operatives and producer groups, and with a large commercial dairy processor will improve the quality of the applied R&D activities and provide inclusiveness for project extension and demonstration activities. For example, lead farmers will be drawn from current co-operative and processor suppliers, and the extended target audience of small and mid-scale farmers will also be accessed through these partnerships. This will also mitigate against the risk that the national research body does not currently have sufficiently close relationships with farmers and the processing/co-operative segment of the industry.

Previous contacts and research: the KALRO-Teagasc relationship has involved work on dairy product processing in 2018 funded by Embassy of Ireland; exposure visits to Ireland to food and dairy research centres and other value chain projects featuring co-operation between Teagasc and KALRO including PhD fellowships in Ireland for KALRO staff.

8. IMPLEMENTATION ISSUES

8.1 Method of Implementation

The project will be implemented by the project implementation partners - Teagasc (lead contractor), Greenfield International, an INGO with substantial Kenyan presence and national research body KALRO.

The full technical resources of Teagasc will be available under the project to support its Kenya-based partners. As the lead contractor, Teagasc will be responsible for overall project delivery and technical oversight. Teagasc will provide Director-level oversight by its Head of Strategy & International Relations, who will commit 20 days over the project lifetime (provided as an in-kind contribution). Secondly, the proposed Technical Director nominated and supported by Teagasc is Dr Seamus Crosse, Greenfield International (co-applicant), whose career as a Teagasc senior researcher/specialist and manager brings considerable experience and also gives him access to current Teagasc manpower resources and thinking. Finally, Teagasc will allocate existing staff from Ireland to provide short-term expert inputs over the life of the project.

The INGO will provide the Project Manager candidate and will provide continuous on-the-ground project management and strong support to outreach activities of the project. The INGO will be required to have the necessary experience to manage the local and financial administration of the project, and to provide office space, manage logistics etc. The Project Manager will be the day-to-day point of contact for the Embassy of Ireland on behalf of the project, will commission external procurement (eg monitoring and evaluation activities) and convene Steering Committee meetings. Teagasc will have overall responsibility of reporting on the project to the client.

KALRO will lead on the core technical research work of the project and will benefit long-term from the strengthening of its innovation management capability through the creation of the Innovation Hub. An important impact of this project is that KALRO Naivasha will be enabled to take a leadership role in the dairy sector, so it is important that they have a strong role in leading the technical aspects of the project, with extensive support from Teagasc, GI and the Project Manager.

Given the importance of innovation support, it is proposed that the project support the recruitment of a full-time Innovation Manager to be assigned to the KALRO innovation unit. The INGO will assist KALRO in the identification and recruitment of the Innovation Manager. This person will bring specific skills in managing knowledge, applying research outcomes, managing relationships with the private sector and co-operatives and will be responsible for supporting KALRO in the delivery of two Work Packages (3.1 and 3.2).

The wider network of project partners will be engaged through project activities. Brookside is the largest dairy processor in East Africa and will be an important partner in terms of extension and outreach activities to its farmer-suppliers. Links with other NGOs will be used to leverage existing relationships with other dairy co-operatives and farmer groups – a summary sheet of potential network of external nodes is included in Appendix 3.

Within the first three months of project kick-off, a project Steering Committee will be formed. It will include the key project partners plus stakeholders such as County Government representatives and nominees of central parastatals such as the Kenya Dairy Board.

8.2 Resource Mobilisation

The scope of this proposal is wide and foresees the creation of transformative data and knowledge for the Kenyan dairy sector. The indicative resource limits (~€1m) mean that the project duration is limited to 2.5 years, whereas ideally the experiments described would continue for several years longer and evolve in terms of sophistication and data quality. Nonetheless, the approach set out can still yield valuable knowledge and capability for the development of the dairy sector in Kenya. Where possible, costs will be minimised by in-kind contributions or efficient use of existing resources and networks. The key resources to be applied to this project are described in Table 10.

Table 10 Key Resources

Technical oversight and project management	Ongoing project oversight provided by Teagasc in association with Greenfield International and SFSI, principally through a Project Technical Director who will be present in Kenya once per quarter. It is proposed that a full-time Project Manager be provided through the INGO partner to manage day-to-day operations and take responsibility for delivery of inputs, day to day reporting and communications on the ground. Each implementing partner will also provide a Director-level resource – Teagasc's Head of Strategy & International Relations; INGO International Director, Greenfield International Director and KALRO's Director of Livestock Systems in project oversight and to participate in Steering Committee meetings.
KALRO research staff	Researcher time on all work programmes.
KALRO Innovation Manager	It is proposed that the project support KALRO to assign or recruit an applied innovation/extension specialist with experience of the dairy sector to act as a key manager of the relationships with the Innovation Nodes and in support of the network of external extension agents and lead farmers.
Short-term Expert inputs	Subject-matter expertise deployed over the period of the project to support deployment and implementation of project activities from Teagasc, SFSI and other sources.
Project administration and backstopping	Project administration, financial management and services on-the-ground.
Livestock & AI	Acquisition of additional livestock for experiments, including AI for on-station replacements.
On-station investment	Land use for forage production and animal and farm systems trials. Upgrading of DRI facilities to accommodate trials such as fencing and land preparation; casual farm labour.
Other consumables	Fertiliser, seeds, forage conservation.
Extension-related costs	Associated with knowledge exchange programme of events, including lead farmer training and support of group activities.

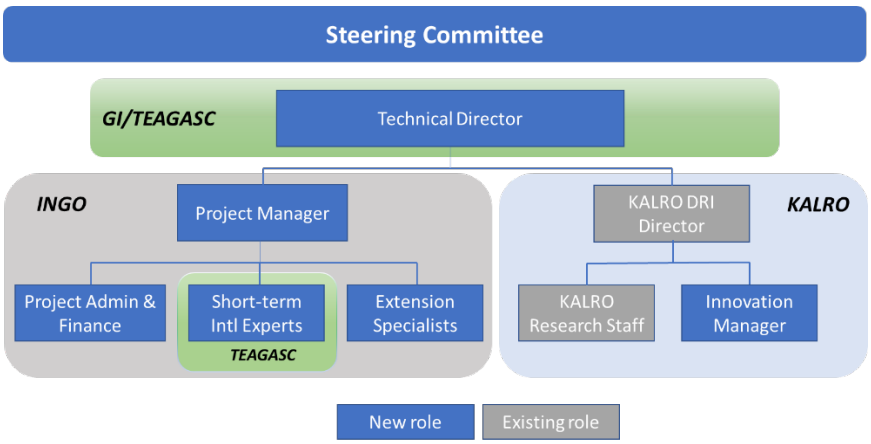
The specific manpower roles created for this project are summarised in Table 11 and organogram presented in Figure 3.

Table 11 Key Roles

Role	**Intensity**	**Description/responsibilities**
Technical Director	Part-time: 110 days	Responsible for scientific oversight and representation of project consortium where required. Key driver of project performance and goal achievement. Present in Kenya at least once per quarter and on weekly conference calls.
Project Manager	Full-time: 30 months	Responsible for delivery of project inputs on the ground through close collaboration with KALRO and oversight of the extension activities of the project. Will take a lead on managing relationships with the value chain

		actors including the Innovation Nodes. Experienced in project management and reporting. Capable of representing the project objectives and results externally and in public events/media. The project manager will work closely with the Technical Director.
Innovation Manager	Full-time: 30 months	To work full-time on upskilling the external innovation network in technical and innovation delivery skills. Responsible for ensuring the Innovation Unit at KALRO is functioning. Acts as a bridge between research and the external network in day-to-day innovation and extension activities. Required to deliver practical on-farm support.
Extension Specialists (x 2)	Part-time: 200 days	Experienced extension resource to work with lead farmers and extension agents in the external network. Require experience of inclusion strategies and methods.
International Subject Matter Experts (4-6)	Part-time: 120 days	Experts in animal breeding, bio-economic modelling, farm systems, livestock and forage provided by Teagasc, SFSI, Greenfield International, ILRI/ICRAF and others in support of specific Work Package tasks.

Figure 3 Project Organogram



8.3 Project Start-up and Inception Phase

It is expected that the central project activities will run over a 30-month period (indicatively from the start of Q4 2019 to the end of Q1 2022. Given that the project is of relatively short duration, it is important that as many resources as possible be available at the start for mobilisation. Immediately after project confirmation/contracting therefore, an Inception Phase should start and run until the start of QIV 2019. In this period, the following tasks can be undertaken:

Table12 Start-up Tasks

Task	**Responsible**
Develop an Inception Plan	INGO
Site preparation works at Naivasha DRI	KALRO
Fodder planting	KALRO
Recruitment of Project Manager	INGO
Assignment/recruitment of Innovation Manager	INGO or KALRO
Recruitment of Technical Director and identification of potential short-term expertise providers	Teagasc/GI/SFSI
Identification of Extension Specialists	INGO
Livestock preparation – trading activities to build experimental herds	KALRO
Linkages formalised with five external nodes	Teagasc/GI/SFSI & INGO

In the Inception Period and as part of project start-up activities, the consortium will draw up various project plans including: development of a project management system, a detailed implementation plan, a financial plan and agreed budget, a procurement plan, a complaints response mechanism, M&E plan, creation of a risk register and communication and visibility strategies. Combined, these will form an Inception Plan.

The summary project delivery schedule is shown in GANTT Chart format in Appendix 4.

8.4 Project Management

During project implementation, the Project Manager, with the support of the Technical Director and other oversight resources will:

- Will assist KALRO Naivasha management so as to ensure individual Work Package tasks are assigned to responsible individuals and monitor implementation based on project timelines. Any adjustments in task implementation will be communicated appropriately to the project steering committee.
- Provide logistical support to KALRO Naivasha in the management of monthly technical meetings which will be used to discuss project progress and check in with relevant staff / implementing partners on delivery of assigned tasks.
- Manage INGO logistics and procurement and provide support as required to KALRO for procurement under its direct responsibility. Robust procurement process guidelines will be presented to the Steering Committee for sign-off during the Inception Period.
- The Project Manager will lead in the development and maintenance of relationships with the Innovation Nodes through interacting with management of the relevant co-operatives or processors.
- The Project Manager will ensure the performance management of the Innovation/Extension Manager and Driver, undertaking performance appraisals and setting objectives. Director-level staff from the INGO will be responsible for undertaking performance management of the Project Manager.
- KALRO and Teagasc will also provide senior level oversight of performance of their own staff that deliver specific inputs on the project.

There will be some overlap between the Project Manager and Innovation Manager in their interactions with the Innovation Nodes. The Project Manager is responsible for development and maintenance of the relationships at a management level, whereas the Innovation Manager will be responsible for day-to-day work in linking research with the extension activities on the ground. Any overlap needs to be managed by the Project Manager to avoid duplication. However, given the short duration of the project and the importance of the extension function, it is important to apply as much in resource as possible.

The Technical Director and INGO project team will conduct periodic monitoring visits in order to track progress, make adaptations where necessary and contribute to on-going learning. The project will track a number of indicators, with data disaggregated by gender and age, designed specifically to monitor and evaluate the impact of activities. Quarterly activity implementation reports will be developed by the Project Manager and disseminated to key stakeholders as per the project governance structure outlined below.

The INGO finance team will provide financial monitoring of the budget and prepare periodic financial reports using comprehensive financial management systems. All partners will submit quarterly financial and programmatic reports to the INGO against planned activities, and quarterly review meetings with partners will be scheduled. The INGO will prepare consolidated financial and narrative reports for review each quarter, with spending reviewed monthly.

8.5 Project Reporting

The project reports will include the Inception Report (described in Section 8.3), Annual Reports including workplans for the following reporting period and quarterly activity and financial reports. A Final Report will close out the project efficiently and include a final expenditure statement and audit and address project legacy issues.

9. INDICATIVE BUDGET

The indicative cost is ~€1M. The budget is separately submitted.

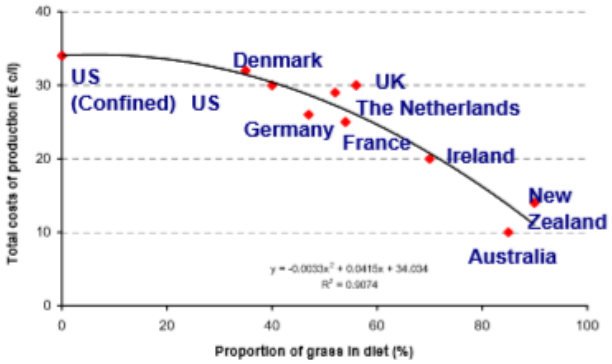
10. IMPACT

There are potentially very significant positive impacts to be gained from undertaking and delivering the DairyKenya project from a KALRO work programme perspective. One of the main impacts will be that of increased competitiveness and sustainability of the farming system. This will be achieved as a consequence

of increased forage in the cow diet and more efficient management of that forage by having the right type of cow; the reduced cost of milk production arising from less use of supplementary concentrate feeds, and improved individual cow management due to greater knowledge of cow requirements resulting from increased knowledge at farm level. There will, in addition, be other important impacts, including improved farmer-family lifestyle, reduced labour demand, improved nutritive quality of milk and improved cow well-being.

This project should enhance the international competitiveness of the Kenyan dairy industry. The results achieved in DairyKenya will contribute to improving the economic position of Kenyan dairy farmers both individually and collectively. A strong relationship exists between the total costs of production and the proportion of forage in the dairy cow's diet (Figure 1; Dillon et al., 2005). This relationship suggests that for a 10% increase in grazed grass in the feeding system, the cost of milk produced will be reduced by 2.5 cent/litre. Preliminary estimates suggest that a similar advantage can be obtained in Kenyan system of production. DairyKenya project will contribute to significant savings through its promotion of forage-based production systems using dairy stock bred to optimise use of forages.

Figure 4: Relationship between total cost of milk production (cent/litre) and proportion of grazed grass in the cow's diet, ranging from total confinement (0% grass) to grass based feed systems (90% grass).



11. RISKS AND ASSUMPTIONS

11.1 Risks

Table 13 Risks and Risk Management Strategy

Risk	Type of Risk	Rating	Risk Management Strategy
Weather-related / drought	Climate	High	- Irrigation at central research station - Include resilience among fodder research criteria to improve options for smallholders - Focus on fodder conservation.
Inadequate finance available for KALRO to adequately fulfil mandate	Economic	Medium	- Continuous monitoring of resource availability on-station; - Credible and detailed budget estimates.
Pace of establishment of Work Packages	Administrative	Medium	- Prioritization of support of Steering Committee - Engagement with multiple stakeholders at an early stage of the Action to ensure objectives and resource pre-conditions are understood.
High staff turnover in beneficiary organisations	Social	Medium	- Ensure sufficiently wide extension network to influence a sufficiently wide number; - Support capability building in beneficiary organisations.
Inadequate leadership and staff buy-in	Social	Low	- Joint planning of activities with key leadership figures; - Focus on longer-term benefit - Work to ensure the project is 'owned' by the participating institutions and partners and not seen as an external project
Inadequate farmer buy-in	Social	Medium/ Low	- Focus on strong and proactive co-operatives and producer groups in project set-up - Focus on innovation support to strengthen farmer relationship with project and KALRO.
Project seen as a project-based approach that lacks sustainability	Social	Low/ Medium	- Ensure all project planning keeps matters of sustainability and adoption at top of agenda; - Focus on embedding the delivery of activities through existing structures/agencies.

Corruption	Social	Medium	- Proactive project communications and visibility strategy; - Rules and procedures related to activities and expenditure; - Establishment of effective project Steering Committee; - Transparency in all aspects of project intervention.
Deterioration in security situation	Social	Medium	- Remain alert to any changes in the security environment.
Resistance from vested interests	Economic	Medium	- Ensure understanding of project objectives through active engagement with Steering Committee; - Take press and PR opportunities to highlight benefits of approach to highlight profitability and sustainability.

11.2 Pre-Conditions & Assumptions

a) Government commitment to continue to support KALRO's efficient functioning.
b) Buy-in from County Governments to project participation and collaboration.
c) Willingness of industry stakeholders to engage meaningfully with research outcomes.
d) Staff and leadership at KALRO DRI have time and resources to participate in project activities.
e) KALRO willingness to adopt an advocacy position in particular in relation to cattle breeding.

12. ALIGNMENT WITH SUSTAINABLE DEVELOPMENT GOALS

The 2030 Agenda for Sustainable Development Goals, adopted at the UN Sustainable Development Summit in September 2015, sets the international agenda for food security. The proposed DairyKenya Project will address issues such as poverty, hunger, gender equality, climate action, inclusive and sustainable food production and trade and also pursue key partnerships to ensure these interventions are institutionalized and sustainable beyond the project period.

Goal 1: No Poverty: the project seeks to raise incomes of smallholder farmers through the use of appropriate breeds of dairy cattle and forage-based production systems, with an overall aim of enabling them to escape the vicious cycle of poverty.

Goal 2: Zero Hunger: The project will promote nutritional messaging, and the importance of diversifying farm enterprises to reduce hunger and malnutrition specifically for women and children. The project will promote dairy farming which will increase the supply of milk for home consumption and for the market. This will improve infant nutrition as well as household nutrition. Improved income due to low cost of production will give greater buying power to the farm family and will also target a greater share of income in the control of women.

Goal 5: Gender Equality: The project will focus on men and women famers. In relation to small scale dairying, women play an important role in looking after the cows and calves. On-farm support for women will enhance the success of the project as well as improving family income.

Goal 9: Industry, Innovation and Infrastructure: the project is designed to promote inclusive and sustainable farming and foster innovation. The food processing business is usually supplied by large scale farmers given the economies of production. However, there is increasing need to involve smallholder farmers. This project will employ innovative approaches in areas such as innovative forage production systems, appropriate breed of cow and innovation support by new Innovation Centre at KALRO will all help to make the value chain effective and practical. Challenges around systems of production based on forage will be addressed.

Goal 10: Reduced Inequalities: Income inequalities in the food chain industry has resulted in companies exploiting producers, primarily smallholder farmers. This pilot project seeks to bridge this inequality and exploitation of smallholder farmers by middlemen and other traders by empowering farmers with vital market intelligence and marketing strategies that will enable them to make decisions on pricing and freedom to choose suitable markets for their produce (milk).

Goal 13: Climate Action: Research from Ireland and elsewhere has shown that production systems based on forage where the 'right' type of animal is used has the effect of reducing the carbon footprint. Information generated from this project will help to derive an improved Marginal Abatement Cost Curve for Agriculture in the Kenyan context.

13. ALIGNMENT WITH DFAT/IRISH AID PRIORITIES

"A Better World", Ireland's new policy for international development, was launched by the Government of Ireland in 2019. It is a whole of government policy and provides the framework for Ireland's expanding development cooperation programme, in line with the Irish Government's commitment to reaching the UN target of allocating 0.7% of its GNI to official development assistance by 2030.

The policy explicitly states that using and building on its national experience, Ireland will work better to harness the collective experience of its public sector to deliver a more effective international development programme, building deeper links between policies at home and abroad. In relation to agri-food, the policy describes how agriculture and food systems are central to a sustainable future and that systemic responses are required to the challenges of increasingly complex human and environmental health. "Smart investment" in sustainable agriculture should also be used to provide youth employment, with a focus on commercialising farms and strengthening agri-food value chains.

In respect of Ireland's own experience, the policy states:

"*The transformation of Irish agriculture, and the associated wealth of technological and market innovation and research, is a basis for Irish engagement with global food systems and markets. Ireland has also developed a unique partnership approach to extension, value addition and to food safety standards. We will explore the potential of harnessing this expertise and experience and identify synergies to add to our development cooperation. This will involve sharing lessons of change with developing countries where relevant and appropriate.*" (A Better World, p27)

This proposed project is entirely consistent with *A Better World* and is a manifestation of the desire to see Ireland's experience of technological and market innovations shared with partner countries like Kenya.

Finally, in March 2019, the European Commission's Task Force for Rural Africa launched its executive report "An Africa-Europe Agenda for Rural Transformation". It identifies four priority areas for action:

1. A territorial approach for income and job creation
2. Sustainable land and natural resource management and climate action
3. Sustainable transformation of African agriculture
4. Development of the African food industry and food markets.

It too encourages the adoption of a food systems approach to agri-food policymaking and investment to build economic, environmental and social sustainability. To transform African agriculture, it wants to see a specific focus on family farming, strengthening farmers' organisations, sustainable intensification and systems-based planning, accompanied by an enabling economic and institutional environment for the sector. It speaks specifically of the need to boost research, education and innovation systems in this transformation effort, for instance, describing much of the existing research base as focused on agronomy, lacking socio-economic strength.

This project will introduce some of this thinking to the dairy sector in Kenya, with a effort to combine economic modelling, a focus on farm-level profitability and an emphasis on innovation support and dissemination.

Appendix 1: Some Key Parameters associated with Innovation Theme/Unit	
1	**Specific Measures** • Establish new theme/unit at KALRO Naivasha to deliver knowledge management and technology transfer functions (including partnership building)
2	**Principal Features** • Innovation support function to be established as a new theme or sub-programme level • Common recruitment and qualifications in line with other research themes or sub-programmes. • Staff complement to include some existing KALRO staff (part time plus 2-3 staff recruited (one staff member initially as part of project). • Head of Centre to be called Head of Research and Innovation and staff to be called Research Innovation Officers in new structure. • Objectives are to ensure that all the research information from the Centre coupled with information from other sources is packaged into usable knowledge for use by Subject Matter Specialists/Extension Officers, private sector extension officers and ultimately by farmers. • Innovation Officers will need a high level of technical knowledge as well as knowledge of innovation and technology transfer. • Ensure that projects at research centres have a high component of knowledge innovation as well as initiatives for knowledge transfer • Performance appraisal of research workers should reflect time devoted to knowledge innovation. Time devoted to research by Innovation Officers also needs to be recognised in performance appraisal. • It is essential that there is integration between the work programmes of innovation unit staff and the Subject Matter Specialists at District level towards achieving effective technology transfer and adoption
3	**Main Benefits** • Faster adoption of new technology on farms. • Greater parity of esteem between Innovation Officers and Research Officers. • More effective feed-back from farm level technical constraints to research centres ensuring more farmer focused research programme • Much improved two-way communication between researchers and subject matter specialist and extension officers.
4	**Institutional Change and Linkages Required** • Innovation support theme must have equal status with other research themes or sub-programmes • Innovation Officers should be recruited at Research Officer grade. • Research Officers will need to get involved in knowledge transfer (change in role profile). • Research Centre manager will have dual responsibility (i.e. equal importance to knowledge generation and knowledge innovation. • Up to 50% of research projects should have a significant component of knowledge transfer incorporated into the project. • This paradigm shift and cultural change within research will be driven through budget allocation and individual performance management.
5	**Challenges / Roadblocks** • Institutional resistance • Researchers do not value knowledge transfer or perceive it as part of their role. • Researchers are mainly driven by academic achievement, publications and peer recognition. • Release of human resources to new function.
6	**Backstopping / Support Requirements** • Full Institutional buy-in from senior management at KALRO. • The role of the Centre manager is critical in this regard. • Create a culture where knowledge management has equal value to the creation of knowledge. • Reward system to reflect excellence in knowledge management as well as research.
7	**Resource Implications** • Human resource development of knowledge management and research staff in the whole area of knowledge management • Provision of ICT Infrastructure • Knowledge management support materials. • Resources required to facilitate engagement
8	**Governance - Monitoring and Evaluation**

	• Strong performance culture at Centre and Department level within Centres. • Role profile of staff reflecting new emphasis on Knowledge management. • Clear KPI's for all staff. • Achievement of objectives to be driven through budget allocation by management.
9	**Other Issues** • While this initiative mainly focuses on the knowledge transfer function it has Centre wide implications. • Technology development needs continued support through collaborative research funding

Appendix 2: Key Functions of an Effective, Comprehensive Dairy Extension System

Appendix 3: Potential Partners in Relation to Establishment of Innovation Nodes in selected Regions – Industry, Co-ops and INGOs									
	Processors & Co-operatives				**INGOs & Community Organisations**				
	Brookside Farm Support Service	**Mukurweini Wakulima Dairy Ltd**	**Keringet Dairies**	**Githunguri Dairy Farmers Co-operative**	**Development Pamoja**	**Solidaridad**	**RTI International /KCD Project**	**Kenya Markets Trust**	**Self-Help Africa**
Type of Organisation	Private sector largest processor	Co-operative and processor LLC	Co-operative	Co-operative	Community based organisation	INGO	INGO/USAID project	INGO	INGO
Location	National	Nyeri County	Nakuru County	Kiambu County	Mogotio in northern Nakuru County	National	12 counties mainly western Kenya	National	National
Number of Milk Suppliers	162,000	7,400 active	6,000 (3,000) Active	13,000 active	-	-	-	-	-
Existing Extension/Training Function	In-house management of extension agents	Yes, 8 agents	Yes	Yes, 14 agents	Partial	-	-	-	-
Contact Person	Titus Kariuki, Extension Services Manager	Charles Mithamo, MPE Manager	Gilbert Rotich	Stephen Msiska, QA and Extension Manager	James Hennessy	Francis Sgivonje Programme Manager	Rita Laker-Ojok, DCOP	Kamau Kuria, CEO	
Comments	45% of dairy market. Have a network of 14 demo / lead farms	Relationship with Technoserve; agents for WWS AI	Established with assistance from SHA		Has land area for demo-farm and a training Centre	Links with 5 co-ops; 2 fully formed dairy "hubs"	Link to market systems development activities	Beef project currently, previous dairy projects	Relationships with Keringet, Bomet and other co-ops

Appendix 4: Project Delivery Schedule