Project Title: *Opuntia ficus-indica*, an emerging animal feeding strategy for drought prone counties in Kenya.

**Annual Report**

**Period Covered:** Oct 2020 - Sept 2021

**KCSAP livestock Applied**

**Value chain:** Livestock-Red Meat

**Duration:** 18 Months

**Start Date:** Oct 2020

**Lead Institution:** KALRO

**PI and contacts:**

John Irungu  
john.irungu@kalro.org

**Collaborators and their contacts:**

1. Bramwell Wanjala
2. Leonard Ateya
3. Elizabeth Mwangi

**Background**

Livestock is an important livelihood resource in the pastoral farming systems of Kenya. Pastoral communities largely depend on the persistence of low-input livestock systems in the country. However, climate change, natural disasters and desertification threaten these livelihood resources, particularly in dry areas (GHF, 2009). Water scarcity, poor quality soils and inadequate supply of quality feed are the major constraints of livestock grazing in the arid and semi-arid regions of Kenya.

The pastoral farmers in dry lands have used migration in search of water and feeds as a coping strategy when faced with droughts. In many cases, this has caused ethnic clashes over limited feed and water resources. Overgrazing of communal land resources has also been a problem, with subsequent loss of livestock. In addition to providing meat and milk for the smallholder farming families, livestock farming has also been a traditional means of earning income. However, livestock production in this region is constrained by poor feed resources resulting from the low productivity of pastures. Animals depend on natural pastures, primarily grasses and tree shrubs. During the dry season there is normally a feed deficit, forcing farmers to move animals to other areas to avoid loss of their animals due to recurrent droughts. The problem is exacerbated by climate change.

*Opuntia ficus-indica* genus; *Opuntia, Family; Cactacea* is the most agronomically important cacti species for the production of edible fruits and cladodes, which can be used as a vegetable and valuable forage resource in arid and semi-arid lands during periods of drought and shortage of herbaceous plants (Scheinvar, 1995; Le Houérou, 2000; Juárez and Passera, 2002). Cacti have specialized photosynthetic mechanism enabling the plant to reduce water loss (Nobel, 1995) offering exceptional possibilities to produce large quantities of biomass that are useful for livestock feed in water-limited areas (Felker et
This study presents an alternative source for feeding livestock in periods of drought, making it possible to adapt low-input production to climate change and contribute to ongoing sustainability.

Objectives

i. To determine the productivity of spineless cactus as drought resilience fodder

ii. To assess the molecular diversity among spineless cactus accessions in Kenya

iii. To develop tissue culture protocol for mass propagation of spineless cactus.

Expected Outputs

1. The productivity of spineless cactus as fodder determined
2. The genetic diversity of spineless cactus assessed
3. Tissue culture protocol for mass propagation of spineless cactus developed
4. At least 500 farmers supplied with tissue culture seedlings for planting
5. Scientific papers and technical reports published.

I ACHIEVEMENTS

Objective 1: To determine the productivity of spineless cactus as drought resilience fodder

Activity 1.1 Collection of spineless cactus plant materials

- Conducting cactus species survey, identify and collect spineless cactus.

Achievement 1.1

- Two potential spineless cacti identified and collected for planting

Activity 1.2: Field maintenance, sampling and data collection

The two potential spineless cactus identified from the collected sample pool were planted at KALRO BioRI Centre, Kabete. The planted materials are maintained in the field as the source of tissue culture explants during the experiment.

Achievement 1.2

- Established field of spineless cactus at the KALRO BioRI Centre

Activity 1.3 Nutritional and biomass yield determination

- A field experiment was set up at KALRO Kiboko with the aim of evaluating the agronomic practices, yield and biomass production of spineless cactus. The experiment was laid out in a split plot design with the main plot treatments being pit and surface planting methods while subplot treatments were fertilizer (N) and manure application at three levels of each. The inorganic fertilizer was applied at N0, N50 and N100 Kg/Ha levels and the farm yard manure applied at FYM0, FYM10 and FYM 20 Tons/Ha levels. Five plants were planted in each plot replicated three times at random.
Achievement 1.3
- Set-up of field experiment at KALRO Kiboko
- Data collection on agronomic practices initiated
- Sampling for yield and biomass production analysis initiated.

Summary of achievements under objective 1
- Two potential spineless cactus identified and collected for planting–by Q1
- Established field of spineless cactus at the KALRO BioRI Centre –by Q2
- Set-up of field experiment at Kiboko – by Q4 (over achieved)
- Data collection on agronomic practices initiated – to end by Q6
- Sampling for yield and biomass production analysis initiated– to end by Q6

Objective 2: To assess the molecular diversity among spineless cactus accessions growing in ASALs in Kenya
Activity 2.1: Germplasm/genotypes collection
- Conducting a survey in the Arid and Semi-Arid counties of Kenya to collect cacti species growing in these regions to establish their diversity. A purposeful sampling procedure was followed to define the sampling units. The GPS coordinates of locations where samples were collected were recorded.

Achievement 2.1
- Some 61 cactus species were collected in Baringo, Laikipia, Machakos, Nyeri, Taita Taveta and neighboring counties.

Activity 2.2: Amplified fragment length polymorphism (AFLP) analysis
- Diversity primers design and application
- Evaluation of genetic diversity of cactus species growing in Kenya by sequence-related amplified polymorphism (SRAP) selection markers system.

Achievement 2.2
- A combination of 48 SRAP primer pairs designed
- Diversity evaluated using the primers and fifteen polymorphic markers identified.

Activity 2.3: Data analysis
- Analysis of morphological characterization of cactus species using XLSTAT2021 Statistical tool.
• Data on the morphological traits observed in the field were recorded based on The International Union for the Protection of New Varieties of Plants (UPOV) derived descriptors list. Morphological data obtained entered in an excel sheet, converted to binary data format and subjected to cluster analysis using Unweighted Pairwise Group Method with Arithmetic Averages (UPGMA) to determine the variations among the cacti.

Achievement 2.3
• Morphological diversity of cactus species growing in Kenya determined;
  - Defined by two component’s namely component 1 and 2; Component 1 influenced by cladode shape, plant height, plant habitus, spine shape, length and width of cladode, central spine twisting while spine size, color, distribution in the cladode, thickness of cladode, cladode color & flower color influenced component 2.

Summary of achievements under objective 2
• A total of 61 cactus species were collected - by Q1 (overachieved)
• A combination of 48 SRAP primer pairs designed –by Q3
• Diversity evaluated using the primers and fifteen polymorphic markers identified –by Q3
• Morphological diversity of cactus species determined. Genetic diversity determination is on-going - by Q4

Activity 3: To develop tissue culture protocol for mass propagation of spineless cactus
Activity 3.1: Plant materials and maintenance
• To obtain explants for tissue culture protocol optimization from cactus planted in 1.2 above

Achievement 3.1
• Maintained cactus field for provision of explants for tissue culture protocol optimization and multiplication.

Summary of achievements under objective 3
• Maintenance of cactus field for provision of explants for tissue culture protocol optimization and multiplication by Q2

II Other achievements (e.g. patents, publications such as journal papers, technical reports, presentation in workshops and conferences ..). List them with proper citations
• KCSAP Applied Cactus project Technical report Q1
• KCSAP Applied Cactus project Technical report Q2
III Constraints and how they were overcome

1. COVID-19 pandemic affected the movement during field work slowing the work. Special permission to allow movement was eventually obtained.
2. Delay in procurement of reagents – initiating procurement early.
3. Limited vehicles at the center delayed execution of field work – borrowed from other centers.

IV Summary of funds received, accounted for and balance

<table>
<thead>
<tr>
<th>Project Amount (KES)</th>
<th>Amount Received (KES)</th>
<th>Amount accounted for (KES)</th>
<th>Balance (KES)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4,660,194</td>
<td>1,380,966</td>
<td>1,305,296</td>
<td>3,354,898</td>
</tr>
</tbody>
</table>

IV Way Forward

Activities Planned for the Period Oct 2021-June 2022

Activity 1: Data collection and analysis for the agronomic practices, nutritional and biomass yield production of spineless cactus

Activity 2: Evaluation of SRAP selection markers, data analysis and mapping of diversity

Activity 3: Tissue culture protocol optimization