**Project Title:** Improvement of crop residues: use of crop residue based spent mushroom substrate as livestock feed

**Annual Report**

**Period Covered:** September 2020 to September 2021

<table>
<thead>
<tr>
<th>KCSAP livestock Applied</th>
<th>Value chain: September 2020 to September 2021</th>
<th>Duration: 18 Months</th>
<th>Start Date: Oct 2020</th>
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**Background**

The available quantity and quality of feed is a major constraint to livestock production in the tropics. The prevailing crop or crop-livestock farming systems mostly produce cereals alongside other major crops. At harvest, these food crops yield large quantities of residues that can be used for livestock feeding. In addition, some cash crops, e.g. sugar cane, also yield significant quantities of residues including tops and bagasse. These residues normally comprise of the above ground part of cereal plants after grain harvesting, and are traditionally fed to ruminant animals, especially in most developing countries.

Chemically, they mainly consist of carbohydrates (mostly fibrous polysaccharides) and are thus, potential sources of energy for ruminants. These fibrous polysaccharides form the major cell wall fraction of the residues and include hemicellulose, cellulose, lignin, cutin and silica. In most crop residues, the cell wall fraction accounts for 60-80% of dry matter (Xiong Yiqiang, 1986). The lignin, polysaccharides and proteins are strongly bound together greatly reducing ruminal micro-organisms’ enzymatic hydrolysis thereby limiting the digestion of the cell walls. However, evidence exist that cereal crop residues used as substrate for mushroom production weakens nutrient bonds attributed to depolymerization of its structural carbohydrates. Consequently, there is a significant increase in digestibility of the residues in the substrate.

Demand for mushrooms has increased worldwide including Kenya where production is estimated to be 500 tons per annum against an annual demand of 1200 tons (NAFIS, 2019). For each ton of mushroom, it is estimated that almost 2 tons of spent crop residue substrate remains. Disposal of these amounts poses and a pollution problem thus an economical disposal option would go a long way to alleviate this problem. This waste, apart from the denatured structural polysaccharides, also comprise of extracellular enzymes, microbes, nitrogen, phosphorous, calcium and other trace elements that can be valuable sources of nutrients for livestock.

**Objectives**

1. Determine chemical/nutritional changes that occur in crop residues when used as substrate for growing mushrooms.
2. Evaluate the effect of inclusion of crop residue mushroom substrate on the growth rate of grower sheep.
3. Determine the effect of inclusion of crop residue mushroom substrate on digestibility of diets.

<table>
<thead>
<tr>
<th>Expected Outputs</th>
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<tbody>
<tr>
<td>1. Data on chemical/nutritive changes that occur in crop residues when used for growing mushrooms</td>
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<tr>
<td>2. Data on growing of sheep fed diets with inclusion of crop residue mushroom substrate</td>
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<tr>
<td>3. Data on rumen function and microbiology as a result of feeding mushroom growing substrates</td>
</tr>
<tr>
<td>4. Data on digestibility of diets containing crop residue mushroom substrate.</td>
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<tr>
<td>5. Data on effect of feeding sheep on heamatology and carcass characteristics</td>
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I ACHIEVEMENTS

Objective 1: Determine chemical/nutritional changes that occur in crop residues when used as substrate for growing mushrooms

Activity 1.1 Short field survey to identify mushroom grower

Achievement 1.1
An initial visit to Jomo Kenyatta University of Agriculture and Technology which train farmers on mushroom growing was made. The University provided some contacts of reliable farms which also train. Based on this referral, an active button mushroom growing facility was subsequently identified in Maragwa, Murang’a County. The farm was selected based on farmers’ knowledge and experience in growing of button mushrooms, willingness of farmer to participate in the project and ability to assist in keeping records.

Activity 1.2: Hire and Prepare mushroom growing premises

Achievement 1.2:
The button mushroom growing facility was identified and the owner was willing to collaborate and offer the facility at no cost. All ingredients required for the mushroom substrate preparation were acquired. In February 2021, the preparation of the media (substrate) for mushroom growing was initiated. The substrate (media) was ready for planting by April 2021. The spawn did not germinate and the process was repeated in early June 2021 at this time the mushrooms germinated. The mushrooms were harvested in October/November 2021.

Activity 1.3: Harvest mushrooms and substrate

Achievement 1.3: Samples of the substrates were collected at the point of planting, middle of mushroom harvesting and at the end of the harvesting. The samples are currently being analysed for the nutrients in the animal nutrition laboratory. Quantity of mushrooms harvested was also recorded.

The substrates have been stored for use in feeding experiment. After incubating the mushrooms and harvesting, data showed that the rice straw was not suitable as substrate resulting in no growth; maize stover was marginally suitable while wheat straw was suitable.
Activity 1.4: Laboratorian analysis
Achievement 1.4: Ongoing

Objective 2: Evaluate the effect of inclusion of crop residue mushroom substrate on the growth rate of grower sheep
Activity 2.1: To formulate and mix TMR feed rations including substrates to be tested
Achievement 2.1: Not done

Activity 2.2: To purchase experimental sheep
Achievement 2.2: Not done

Activity 2.3: Perform feeding trial
Achievement 2.3: Not done

Activity 2.4: Perform invivo digestibility of formulated rations
Achievement 2.4: Not done

Activity 2.5: Blood collection during feeding trial and hematolgy and clinical pathology analysis
Achievement 2.5: Not done

Activity 2.6: Carcass characteristics and meat quality assessment
Achievement 2.6: Not done

Objective 3: Determine the effect of inclusion of crop residue mushroom substrate on digestibility of diets

Activity 3.1: Rumen fistulation
Achievement 3.1: Not done
Activity 3.2: Rumen sample collection and analysis
Achievement 3.2: Not done

Other achievements (e.g. patents, publication such as journal papers, technical reports, presentation in workshops and conferences etc.). List them with proper citations

None at the moment

Constraints and how they were overcome

1. COVID 19
The funds were disbursed in October 2019 but implementation of activities was hampered by COVID-19 pandemic since there was minimal activity due to lockdown in 2020. Scouting for suitable mushroom house did not start until late January 2021.

2. Test substrates not working fast enough
The common substrate for mushroom growing is wheat straw. Maize stover and rice straw were being tested for suitability the first time (TIMP). They took longer than anticipated to be fully ready for planting causing a delay of three weeks.

3. Ineffective spawn
The mushrooms did not germinate and after 14 days of waiting was advised the seed was not viable.

4. Availability of raw materials
It was decided to embark on another attempt and use different spawn (from another supplier) but due to seasonality of the availability of the crop residues, the preparation of growing of the second crop did not commence until June 2021.
Preparation of the new substrate commenced in mid June. The planting was done in august and harvesting commenced end of September to early November.

5 Slow to adapt substrate preparation to rice straw and maize stover
At planting it was noted that the rice straw and maize stover substrate became very dense (compacted like manure) with anticipated problem of mycelium growth. It was decided that the two substrates be spread out in a thinner bed (to minimize the height/compaction) during planting.

6. Delayed accounting
Due to all these delays, the initial funds disbursed have partly been utilized but not accounted for.

7. Delayed project implementation
The project implementation has been delayed as a whole and we shall request for a no cost extension to achieve some of the objectives. The extent of extension request will depend on the outcome of the currently analysis of nutrients in the substrates.

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>
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<tr>
<td>4, 757,642</td>
<td>487,370</td>
<td>0</td>
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IV Way Forward
Activities Planned for the Period Oct 2021-June 2022

Laboratory Analysis:
The samples (crop residues and spent mushroom substrate) are currently being analysed for:
-dry matter, ash, crude protein, crude fat and crude protein
-Mineral content: (Ca, P, Mg)
Fibre analysis: The Neutral detergent fibre, acid detergent fibre, acid detergent lignin (cellulose and hemicellulose content will be calculated from the NDF and ADF values).
In vitro DM digestibility: through the 2-stage artificial rumen technique

In-sacco degradability:
By use of nylon bag technique

In vitro gas: Through use of modified Menke gas test.

Feeding trials
Collection of data on growing of sheep fed diets with inclusion of crop residue mushroom substrate
Data on digestibility of diets containing crop residue mushroom substrate

Publications and dissemination
These will be done as data is collected and analysed until end of project