NASENI RESEARCH COMMERCIALIZATION PROPOSAL

ON:

ESTABLISHMENT OF PLANT FOR THE PRODUCTION OF LIVESTOCK FEEDS USING HERBACEOUS WEEDS AT BAYERO UNIVERSITY KANO

AT:

BAYERO UNIVERSITY KANO, NIGERIA

NEW CAMPUS, GWARZO ROAD, KANO

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Executive Summary

Livestock farming in North-Western Nigeria has significantly decreased due to shortage of feeds, especially during the dry season. The livestock feeds became very expensive, causing many smallholder farmers to quit the business. This, in return, results in the shortage of livestock products in the country. Been in the savannah region, the vegetation of North-Western Nigeria supports the growth of a wide variety of herbaceous weeds that occupying every nook and crannies of the unbuilt spaces, causing various inconveniences. These plants are hard to control due to their invasiveness, and are usually burnt during the dry season, and in so doing, causing a lot of destruction to the environment and biodiversity. Millions of tons of these herbaceous weeds, especially the graminoids that could be used in producing nutrient-rich animal feeds, are wasted every year. The proposed intervention will find a way of utilizing the herbaceous biomass in producing microbes-fortified animal feeds, thereby introducing sustainable management approach for these weeds, while addressing the feeds shortage and improving livestock farming, especially among the smallholder farmers in North-West and Nigeria at large.

The intervention will involve the identification of the graminoid weeds, and the determination of their nutritional compositions and anti-nutritional factors using standard procedures; preparation of the biomass; identification of the sources of nutrient from some selected algal and fungal species; preparation of various formulations of fortified feeds based on the nutritional requirements of the livestock using Solid State Fermentation (SSF), and the assessment of the developed formulations on the health, growth and reproduction of the animals. Research on the production of the feed has already been conducted and the results of the study has been sent for publication. The establishment of the fortified feed production is estimated to cost the sum of Three Hundred and Fifty-Five Million Naira (N355 million) only.

1.0 Introduction

The global food supply is experiencing considerable changes in the production and consumption patterns in the recent years (Izah *et al*., 2017). The current increase in the global population, with concomitant increase in the demand for livestock products, has led to the need for intensive livestock production. This has also led to the need for adequate supply of feed materials, which need to be sustainable, safe for the animal consumption, and free of undesirable or toxic substances that could compromise the quality and safety of animal-derived foods. Animal feed is a critical component of the food chain with direct impact on animal health and reproduction, as well as on the global food safety and public health (Aziz *et al*., 2019).

Livestock farming has been one of the major economic activities in North-Western Nigeria, serving as the source of wealth and food for the nation (Ilu *et al*., 2016). The region has a long history of supplying livestock products such as meat and leather to the Southern part of the country

and other parts of the world (Jones, 1946; Rekwot *et al*., 2022). According to the Food and Agriculture Organization of the United Nations, livestock sector has the potential to support the transformation of the country socially and environmentally in a sustainable way (FAO, 2019). The sector is mostly dominated by smallholder farmers, who face various challenging situations in terms of infrastructure, access to finance and credit facilities, animal health, and regulatory frameworks (Adepoju *et al.*, 2021). Moreover, the increasing cost of feeds and inputs, over-dependence on imported feed ingredients, and the inadequate local production of feeds, insufficient investment in developing feeds production facilities, and inadequate research and development are substantially affecting the livestock farming, exposing both the human and animals to malnutrition and other related diseases in Northern Nigeria (Bamaiyi, 2013; Integrated Food Security, 2023; Chukwuka, 2024).

Been in the savannah type of vegetation, the North-Western region of Nigeria has a climate that support luxurious growth of herbaceous weeds, especially during the rainy season. Herbaceous weeds are plants with flexible green stems, usually considered undesirable in a particular situation, typically found along roadsides and streets, within some government agencies, around the industries and residential areas, and in educational institutions, where they invade the premises, making a lot of inconveniencies (Otitoju *et al*., 2019). The herbaceous weeds in North-Western Nigeria comprises of both forbs and graminoids, with broad diversity. Graminoids are herbaceous plants with grass-like features: elongated culms and long blade-like leaves. In contrast, forbs are plants with broadleaves and net-like veins in the leaves (Booth *et al.*, 2018). Graminoids produce abundant and an inexhaustible biomass that can be used for the generation of a wide range of bioproducts, including animal feeds (Nikiema *et al*., 2022).

Herbaceous weeds such as *Paspalum vaginatum, Bothriochloa sp., Heteropogon sp., Hyparrhenia sp., Dichanthium sp.,* and *Cynodon sp., Eragrostis tremula*, among others, are the most abundant graminoids in North-Western Nigeria. Biomass from lignocellulosic herbaceous weeds is composed of cellulose (40 – 55%), hemicellulose (25 – 40%), lignin (15 35%), extractives, and several other vitamins and minerals, as well as inorganic materials. However, the utilization of this resourceful biomass has been marginalized; the plants are usually mismanaged during their growing season, and are normally burnt during the dry season. It is estimated that millions of tons of this important resource are wasted every year through burning and other unsustainable

approaches, causing a lot of destruction to the biodiversity, polluting the environment with toxic gases, in addition to the emission of greenhouse gases into the atmosphere (Izah *et al.*, 2017).

Biomass from herbaceous weeds can be processed into affordable nutrient-rich feeds when fortified with other sources of nutrients such as those from algae and fungal species (Aziz *et al*., 2018). Microalgae are rich in protein, dietary fiber, fatty acids, vitamins (including A, C, D, E, K, and B vitamins), and essential minerals such as iron, calcium, magnesium, and potassium. Species such as *Chlorella* and *Arthrospira* (*Spirulina*) contain 50 – 70% protein by dry weight, comprising of all the essential amino acids (Geada *et al*., 2021), making them valuable nutrient sources (Barkia *et al*., 2019). Likewise, similar nutrients is found in the biomass of some filamentous fungi such as *Fusarium*, *Aspergillus*, among others, and scan be used, in combination with biomass to produce nutrient-rich animal feeds (Rousta *et al.*, 2022). Fungal species can also be used to ferment the pretreated weed biomass in the generation of sustainable feeds with increased nutritional value (Li *et al*., 2023).

It is against this background that the proposed intervention was designed to evaluate the microbial biofortification in the production of livestock feeds from herbaceous weeds, with particular interest on graminoids, in North-Western Nigeria. This is with a view to addressing lower productivity of livestock farming, especially among smallholder farmers in the region and the country at large.

1.1 Statement of Problem

Livestock farming is an important business that is known to improve the well-being of smallholder farmers in the climate-vulnerable areas of North-Western Nigeria. It plays a vital role in providing food security, employment opportunities, and contributes to the Nigeria's GDP. Livestock farming is anticipated to make a significant transformation of the Nigeria's economy by the year 2050 if the proper interventions are put in place (Otitoju *et al*., 2019). However, Nigeria is witnessing a series of challenges in the livestock sector in the recent years, especially in Northern part of the country, where the majority of the farming activities is taking place. Lower productivity of livestock farming in the region is caused by inadequate nutrient-rich feeds throughout the year, deficiency of technical-know-how on fortified feeds production, and inadequate storage technology, among others (Li *et al*., 2023).

Precipitation in North-Western Nigeria is seasonal, and the grasses that grow in abundance during the rainy season are mainly annual, drying when the rain stops. This makes it difficult for the smallholder farmers/herders, in particular, to provide sufficient nutrient-rich feeds to their livestock during the dry season (Izah *et al.*, 2017). Moreover, the pastoralists have little technical-know-how in utilizing the abundant grasses during the rainy season to produce fortified animal feeds for feeding their livestock, especially during the dry season. They have inadequate knowledge to develop storage technologies for the preservation of the feeds for efficient use throughout the year. These are the major causes of the lower productivity in the livestock farming system in North-Western Nigeria. As a result, livestock farming faces various challenges in the region, including the continuous increase in the prices of feeds and livestock products, farmer-herder conflict, among others (Otitoju *et al*., 2019).

The proposed project hypothesized that, the abundant herbaceous weeds in North-Western Nigeria can be used to produce nutrient-rich affordable livestock feeds and fortified using microbial nutrients. An effective storage technology can be developed for the fortified feeds so that it can be available throughout the year. The smallholder farmers can also be trained on the production and storage of the fortified feeds from the herbaceous weeds so that it can be available and affordable always. This will address lower productivity in the livestock sector and the associated consequences described above, with eventual improve in the socioeconomic development in the region and the country at large.

The proposed intervention therefore comes with some research questions to guide the conduct of the project.

1.2 Objectives of Establishing the Plant

1. To produce high-quality livestock feeds that meet the nutritional needs of animals.
2. To promote sustainable agriculture and reduce environmental degradation.
3. To create employment opportunities and stimulate economic growth in the local community.
4. To generate revenue for Bayero University Kano through the sale of feeds and related products.

1.3 Conceptual Framework of the Proposal

Generally, livestock farming in Northern Nigeria is dominated by smallholder farmers, who rely on the grasses that grow during the rainy season to feed their animals, and when the dry season comes, they feed the livestock with provender, which is not enough to provide the essential nutrients required for optimum growth and reproduction. This has caused the current increased in animal malnutrition and other related challenges in the region. There is abundance of grasses in the region been it under the tropical grassland area of the African savannah vegetation; but more 70% of it is wasted every year through burning and other unsustainable practices. Biomass from these herbaceous weeds can be harvested in sufficient quantity during the rainy season, processed and fortified to produce nutrient-rich livestock feeds. Some selected algal and filamentous fungal species can be an excellent source of nutrients for the fortification of the biomass from herbaceous weeds. Multidisciplinary and interdisciplinary collaborations is therefore needed to develop nutrient-rich biofortified livestock feeds from the herbaceous weed biomass; and this will go a long way in addressing the current lower productivity of livestock farming, especially among smallholder farmers in North-West and Nigeria at large.

1.4 Project Goals

Short Term Goals:

1. Development of affordable fortified feeds for livestock. This will address the inadequacy of affordable fortified feeds, especially during the dry season, in North-West and Nigeria at large.
2. Development of packaging and storage technology for fortified feeds from herbaceous weeds biomass. This will ensure the efficiency and availability of the microbes-fortified feeds in North-Western Nigeria throughout the year.
3. Improvement of the technological skills of smallholder farmers with regard to the production and storage of microbes-fortified livestock feeds from herbaceous weeds in North-Western Nigeria.

Long Term Goals:

1. Establishment of a reliable data on the floristic, biodiversity, relative abundance, nutritional and anti-nutritional compositions of locally available herbaceous weeds (graminoids) in North-Western Nigeria. This data is very scarce in the literature.
2. Introduction of eco-friendly and sustainable management system for herbaceous weeds in North-Western Nigeria. This will address destructive management approaches such as burning.
3. Improvement of the productivity of livestock farming, especially among smallholder farmers in North-Western Nigeria, thereby improving their socioeconomic status.
4. Provision of adequate and healthy livestock products in the region and Nigeria at large. This will ensure availability and affordability of the products in the country.
5. Commercialization of the fortified animal feeds within and outside the country. This will increase the generation of revenue in the country

1.5 Project Impact

Social benefits:

1. With increase in the prices of livestock products, many people have given up eating meat, egg, and other related foods. This proposed intervention will make the livestock feeds available and affordable, reducing the prices of the livestock products. This will lead towards achieving SDG 2 (Zero Hunger).
2. Farmer-Herder conflict will be reduced and gradually eliminated in the region, achieving SDG 16 (Peace, Justice and Strong Institutions).
3. Environmental pollution and degradation due to burning of dried weeds will be reduced in the region, thereby developing a healthy and safe environment, achieving SDG 3 (good health and well-being).

Economic benefits:

1. Creation of productive employment opportunities in the region, as both skilled and unskilled labours are required to harvest and supply weeds, produce the fortified livestock

feeds, and trade it to end users, achieving SDG 8 (decent work and economic growth).

2. A transition to sustainable production of fortified animal feeds from herbaceous weeds will be encouraged in the region, thereby boosting small and medium scale businesses and revenue generation, achieving SDGs 1 (no poverty), 2 (zero hunger), and 8 (decent work and economic growth).
3. Livestock farming will be improved in the region, especially among smallholder farmers, increasing their daily earnings, achieving SDG 8 (decent work and economic growth).

Technological benefits:

1. Unskilled labourers and smallholder farmers in North-Western Nigeria and the country at large will acquire technological skills involved in the production of fortified livestock feeds from herbaceous weeds, and this may lead to achieving SDGs 1 (no poverty), 2 (zero hunger), and 8 (decent work and economic growth).
2. The development of packaging and storage technologies will go a long way in the preservation of related products in the region and the country at large, achieving SDG 9 (industry, innovation and infrastructure).
3. Novel and sustainable technological approaches for the utilization of biomass from lignocellulosic herbaceous weeds will be reported in the study and published, which can be accessed and used by future researchers in similar works, achieving SDGs 4 (quality education) and 9 (industry, innovation and infrastructure).

2.0 Literature Review

Studies on the abundance, distribution, utilization of herbaceous weeds to produce various valuable bio-products have been extensively carried out by authors from different fields of knowledge across the world. According to the International Crisis Group (2018), among the greatest challenges facing the provision of food to any community is not just the shortage of the food, but also the issue of unbalanced diet. Adding the livestock products to the diet helps in compensating several nutritional deficiencies, improving the immunity, growth and well-being (Gavrilova, 2020). Livestock farming is of prime importance in providing draft power and a source of income to millions of smallholder farmers in Northern Nigeria (Sanni *et al*., 2021).

Babatunde (2015) assessed the feed resources use and farming practices Northern Nigeria by agro-pastoralists with a view to suggest points for improved range and livestock performance through nutritional manipulations, basing the study purpose on shortage of feeds and feed resources for livestock consumption during the dry season. Feed Assessment Tool (FEAST) developed by International Livestock Research Institute, Kenya which comprises of a database software and two sets of questionnaires, were employed in the study. The results of the study showed that throughout the year, there is shortage of feed resources in Northern Nigeria for sufficient livestock farming, and that the availability of feed resources is greatly influenced by the seasonal rainfall that comes between June and December. It was concluded that the management practices toward livestock feed resources, such as protein supplementation, processing of green fodders into silage and improve utilization of crop residues and by-products are the recommended options for reducing the shortage of feeds and feed resources in the affected areas.

Leondro *et al*. (2024) considered the utilization of the high diversity of herbaceous legumes in Indonesia as the potential source of animal feed. Their study identified eight herbaceous legumes and determined their productivity and nutritional value. These were *Macroptilium bracteatum, Centrosema pubescent, Clitoria ternatea, Calopogonium mucunoides, Pueraria javanica, Dolichos lablab,* and *Stylosanthes guainensis*. The plants were found to have high nutritional content and have the potential to be developed as animal feed, especially in tropical areas.

Salisu *et al*. (2021) determined the phytosocial diversity and distribution of herbaceous weeds in North-Western Nigeria. A total of 4372 weed species from 44 genera were collected using quadrat method, identified and analyzed. Species from the families of *Fabaceae, Poaceae,* and *Amaranthaceae* have the highest rate of occurrence, followed by those from *Asteraceae, Cucurbiataceae, Rubiaceae, Cleomarceae, Cyperaceae,* and *Phyllanthaceae*. *Teprosia pedicelata* had the highest species distribution, followed by *Mitracarpus scabrunzuce*, and *Leucus martinicensis*. Moreover, *Citrilus colosyntnthus*, *Phyllanthus amarus*, *Sesbania sesban* and *Eragrotis tremula* were the rare species found at the study area. Approximately 70.45% of herbaceous species shows aggregate distribution and 29.55% random distribution pattern. Similarly, Jimin *et al*. (2022) carried out a study to determine the distribution of herbaceous weeds at the University of Abuja main campus, in which a total number of 39 species were

identified, including Hyptis suaveolens (mint weed), *Calopogonium mucunoides*, Sida acuta, *Paspalum vaginatum* and *Tridax procumbens*.

Yafetto *et al*. (2023) conducted a review on the global and local Ghanaian biotransformation and valorization of agro-industrial wastes such as cassava peels, rotten pineapple, plantain, and banana, as well as rice bran, rice husks, corn husks, corn cobs, wheat bran, palm kernel cake, among others, into animal feeds through Solid-state fermentation (SSF), This microbial fermentation process is a viable efficient approach that transforms plant waste such as the biomass from herbaceous weeds into detoxified nutrient-rich animal feeds with remarkable digestibility. The microorganisms used in SSF are generally safe, and include some fungal species such as *Aspergillus, Trichoderma, Rhizopus, Mucor, Penicillium, Fusarium, Saccharomyces, and Candida, and some bacterial species, including Bacillus and Lactobacillus, among others.*

Rousta *et al*. (2022) determined the nutritional content of *Aspergillus oryzae* biomass produced through submerged fermentation using airlift bioreactor, with oat flour as the substrate. The nutritional contents, including amino acids, fatty acids, minerals (Fe, Zn, Cu, Mn), vitamins (E, D2), and dietary fiber were studied and compared to oat flour as well as that of pure fungal biomass grown on semi-synthetic medium. Increase in the level of amino acids from 11% per dry weight (dw) in oat flour to 23.5% dw in oat fungal biomass was found, with increased relative ratio of essential amino acids (0.37 to 0.42). Similar results were obtained in dietary fibers, minerals (Fe, Zn, Cu), and vitamins. Short chain omega-3 α-linolenic acid (ALA) and omega-6 linoleic acid (LA) values were also increased from 0.6 to 8.4 and 21.7 to 68.4 (mg/g dry weight sample), respectively, in oat fungal biomass.

According to Husein and Diriba (2024), herbaceous weeds can be conserved to feed animals during periods of shortage due to limited pasture growth or inadequate pasture conditions, and can be used as supplement; and this can take the form of haylage, hay, pellet, or silage, among other forms. The review concluded that adequate nutrition is the most important factor affecting livestock productivity; and that ration formulation is highly significant when it comes to the processing feed ingredients into a formulation that will meet the nutrient requirements of animals for improving livestock productivity.

3.0 Production Processes

3.1 Weeds Identification

To ensure sustainable supply of the biomass for feeds production, more herbaceous weeds will be identified in addition to the ones used in the research work. The proximate, nutritional, and phytochemical compositions of the species identified will be determined using standard procedures as was done during the research work.

3.2 Biomass Collection

Herbaceous weeds are in abundance in both the campuses (Old and New Campuses) of Bayero University Kano; the collection of plant biomass for feeds production will therefore be in collaboration with local people from the surrounding communities. They will be engaged in supplying the biomass to the production plant based on the agreed prices. Biomass collection from and feeds production will be intensified during the rainy season when the plants can regenerate continuously, providing a sustainable supply.

3.3 Supplementary Biomass

Plant species with remarkable nutrient content but not available in BUK and the surrounding, such as Azolla, will be brought and cultivated on regular basis to enrich the fortified feeds.

3.4 Cultivation of Fermenting Microorganisms

Facilities for the cultivation of microorganisms to be used in the solid state fermentation will be provided; broth cultures will be considered for the production purposes. Microorganisms, including Bacillus subtilis, Lactobacillus acidophilus, Aspergillus species, Saccharomyces cerevesiae, among others, will considered for the production processes.

3.5 Feeds Production

Preparation of the feeds will be in accordance with method employed in the research work as described by Goliński and Foltynowicz (2012). This will be based on the results of the analyses

carried out on the plant samples, and will depend on the nutritional requirements of the animals. Ruminant animals are relatively unique in their nutritional requirements, with five key nutrients, including fibre, crude protein, lipid and water-soluble minerals and vitamins. The feeds will be prepared in the form of silage and pellet due to the fact that, this will reduces waste generation during the production processes. The production processes will involve various steps, including crushing, formulation, fermentation, pelletizing, drying and packaging.

Crushing: The herbaceous biomass will be crushed using cyclone hammer mill, grinding the plant materials into powder.

Fermentation: Solid State Fermentation will be employed in the preparation of the feeds in this study. This will involve mixing the powdered biomass with fermenting organisms isolated and identified in the study, and placing the mixture in fermentation reactor. The fermentation will be carried out according to the manufacturer's instructions.

Formulation: This will involve the appropriate mixing of the fermented biomass with nutrients sourced from the algal and fungal biomass cultivated in the study. Mixing will be totally based the findings of the analyses as well as the nutrient requirements of the individual ruminant animals. Excessive addition of the nutrients will be avoid to ensure appropriateness.

Pelletizing: This will involve the production of pellets from the fermented formulations using pelleting machine. High quality machine will be procured for this purpose to ensure production of quality products.

Drying: The pellets produced will be dried to ensure absolute removal of moisture and enhance storage of the feeds for longer period of time.

Packaging: The silage and the pellet will be packaged according in appropriate bags.

3.6 Quality Assessment

This will be carried out in two phases: Pre-Ingestion and Post-Ingestion. The pre-ingestion will involve the examination of the finished product to determine its nutrients content and compere with standard requirements of the ruminant animals, while the post-ingestion will involve feeding

the animals and later the impact of the feeds will be determined digestibility and live weight change (Marinho *et al*., 2020). To develop standard feeds, a number of some selected livestock, including cattle, sheep and goats, will be purchased and used as test animals. The test animals will be fed with the developed feeds for a month, and they will be under careful monitoring to assess their response to the feeds efficiency (Bollatti *et al*., 2020). The standard developed will be used for regular quality assessment whenever the feeds are produced.

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4.0 Ethical and Environmental Considerations

All the activities in the study are not harmful to environment and biodiversity; the methodologies are eco-friendly. The research activities and disposal of waste such as used chemicals and broken glassware will be carried out according to the Bayero University Kano ethical and environmental protocols.

5.0 Monitoring and Evaluation Mechanism

There will be a sub-committee in the production team that would be responsible for monitoring and evaluation in order to ensure timely completion of the project activities as scheduled. There will be a good synergy between members of the research team and the production team; and the Principal Investigator shall coordinate the activities of the production processes. A regular meeting will be conducted to assess the progress of the project; and a template will be designed for the assessment of the milestone achieved during the project. Moreover, a quarterly reports will be presented to the production authorities (see the Business plan) to account for the project finances and man power status of the project activities. The report will serve as a guide to the production and commercialization teams in conducting the project activities.

6.0 Composition of the Research Team

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