AGRICULTURAL AUTOMATION, CLIMATE CHANGE-ACTION AND FOOD SECURITY: GLOBAL ISSUES & LOCAL PERSPECTIVES

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AGRICULTURAL AUTOMATION, CLIMATE CHANGE-ACTION AND FOOD SECURITY (GLOBAL ISSUES & LOCAL PERSPECTIVES)

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Preface

This book adopts an exegetical approach as well as a pedagogic model, making it attractive agriculture and environmental economics teachers, professional practitioners and scholars. It is eschews pedantry and lays bars the issues in such clarity that conduces to learning. The book elaborates on contemporaneous Agricultural Automation, Climate Change-Action and Food Security issues of global significance and at the same time, is mindful of local or national perspectives making it appealing both to international and national interests. The book explores the ways in which Agricultural Automation, Climate Change-Action and Food Security issues are and should be presented to increase the public's stock of knowledge, increase awareness about burning issues and empower the scholars and public to engage in the participatory dialogue Agricultural Automation, Climate Change-Action and Food Security necessary in policy making process that will stimulate increase in food production and environmental sustainability. Agricultural Automation, Climate Change-Action and Food Security**:** *Global Issues & Local Perspectives* is organized in three parts. Part One deals with The Concept of Agricultural Automation, Part Two is concerned with The Concept of Climate Change-Action and Part Three deals with the Concept of Food Security

Eteyen Nyong; October 2026

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Chapter Nine

Musa Paradisiaca (Plantain) Production in A Climate Change Agriculture

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Introduction

Plantain (Musa paradisiaca) is a giant herbaceous plant and occupies a strategic position for rapid food production in Nigeria. It is ranked the number three (3) among starchy staples. Production is dominated by the small-holders/male adults; while the female adults handles the processing of and marketing aspect (Britanica, 2016). The total leaves produced by a plantain plant is between 42 – 62 throughout its entire growth cycle, which usually lasts between 9-12 months depending on the climate and environmental conditions. Dutta (2002), stated that plantain leaves die off more rapidly during the dry season, compared to the rainy season (9-15 weeks longitivity). Swenna (2000) reported that a plantain can mature a healthy bunch with as few as 6-12 functional leaves remaining. In about 2-3 months after flowering, the bunch becomes matured. The biological value (BV) of plantain is carbohydrate: 50.1g, Protain: 5.5g, Fat: 0.3g, and fibre 5.8g. Consumption cuts across social, religious and ethnic barriers.

Production capacity for plantain is about 3.11 million metric tonnes/year. Sadly, post-harvest losses are as high as between 20-40%. Today, Nigeria is one of the largest producers of plantain and banana in the world. (FAO, 2011) Despite its prominence, Nigeria still does not feature among plantain exporting nations. This could probably be due to the fact that it produces more for local consumption than for export (Ogungbe, 2005). The consumption of plantain in Nigeria has increased in recent years. This is because plantain and plantain by-products are being used more in livestock production, urbanization and other industial purposes (Kainga, 2013). However, the challenge before plantain farmers is the prolonged climate change which is adversely affecting production. The recent fluids ravaging some parts of Nigeris in the past two decades has caused lodging of large quantities of plantain plants (trees) and huge losses of livestock annually. In the final analysis, the practitioner always experience huge and post-harvest losses, scarcity of livestock (poultry and animal

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meat), and thereby causing demand to be higher than supply (Kainga, 2013) and (BYSG, 2003).

Economic Importance of Plantain

1. Food Value: The crop is a rich source of carbohydrates, dietary minerals, vitamins and crude proteins. It could be eaten boiled, fried, roasted, mashed and mixed with ingredients as Dudo Ikare, and even raw as dessert. (Kainga and Seiyabo, 2012).

2. Export Value: Plantain is a good export crop. The international trade in plantain has continued to grow in recent times. As a cash crop, plantain can earn the country enormous foreign exchange. The local market is very large.

3. Medicinal Value: Plantain have high medicinal values in the management of diabetes, stomach ulcer, tonsilitis etc. Extracts from the roots, peels and leaves have been effective in treating penile dysfunction and increased libido.

4. Livestock Feed Value: The peels of the fruits, bunch stalks and meristem, are good livestock feed materials for livestock feeding.

5. Industrial Value: Every part of plantain is very useful and have attractive industrial potentials. The flour of the fruits have valuable pharmaceutical and confectionary industries. Whole or composite flour serve as base for preparation of syrups. It is also an ingredient in the preparation of baby foods (e.g. Soya Musa). The fruits are also raw materials for production of wine, juice and gin. The peels are processed into cosmetic soap (e.g. Ose Dudu) and a source of local tenderizer. It is high in organic potarsh. The stems produce fibre materials for industrial ropes, fancy bags and mats, weavon, rugs.

Climate Change Agriculture

Climate change refers to any significant change measure of climate lasting to a period of time, decades or longer (Ekunwe and Ajayi, 2010), The following natural factors can bring about climate changes in the earth's orbit around the sun, and natural processes within the earth's system such as changes in ocean circulation. Also, human activities have changed the composition of the atmosphere through burning, urbanization, desertification, etc. Allisson-Oguru et al, 2008), reported that the climate change is likely to contribute substantively to food insecurity in the future. It added that while food production will reduce, there will be increasing food prices.

As man increases its activities, the atmosphereic gases are increased in the atmosphere. In this way, more and more heat is trapped causing global warming, which hitterto, leads to climate ghcnge. Today, climate change affects agriculture in a number of ways as may be seen in average temperature, rainfall, and climate extremes like heat waves. That is, climate

parameters are inducing changes in areas such as pests and diseases, atmospheric carbondioxide and ground-level ozones concentrations, nutritional qualities of some feeds, sea level productivity, wild life and heat wave incidences.

- **Impacts of Climate Change**

Moore et al (2008), reported that climate change has led to a distortion of seasonal patterns. Similarly, A and Ogungbe (2005), reported that increase in regional temperature as a result of climate change, particularly in the tropics, can lead to heat stress for all types of quality, harvest time and storage of crops and livestock. In a related development, Allison-Oguru et al, (2008), reported that rainfall variation is expected to continue to increase in Nigeria, adding that precipitation in southern Nigeria is expected to rise, exacerbating the risk of flooding and possible submersion of coastal cities and fadama. In addition, fluctuation in temperature and rainfall are said to bring about increases in the severity and occurrence of plant diseases, insect outbreaks and outbreaks of pandemics such as of Covid-19, monkey pox, migraine headache, etc. (Ekunwe and Ajayi, 2012). Similarly, the losses suffered by food crop (yam, plantain, sweet potatoes, etc) and livestock (poultry, sheep, goats, snails) farmers due to disease outbreak, scarcity of feed, high cost of feed ingredients and veterinary drugs/vaccines has forced many practitioners out of business.

This study seeks to properly educate prospective farmers on how to manage the changing climatic conditions using common sense on plantain production and its potential as a feed resource in livestock feeding.

- **Botanical and Common Names**

Plantain belongs to the family: Musa spp (35 different species). Genus: 1. Musa paradisiaca (plantain, edible). 2. Musa sapientum (Banana, edible), 3. Musa superb (ornamental, not edible); and 4. Musa sanguine (Assan, not edible). (Dutta, 2002).

Different tribes and languages have their native names for plantain. Yoruba (Ogede), Igbo (Hubo), Hausa (Ayaba), Izon/Ijaw (Beribe, Abangha).

Origin and Distribution

Plantain originated from South East Asia through the pacific ocean. It is a native to Europe and some pats of America. Then, it moved through India to Africa and finally to Nigeria.

The distribution pattern is that plantain thrives well in Southern Nigeria, but reduces up to the middle belt. In Northern Nigerian, plantain do not perform well.

Agronomic Practices for Good Yields and Economic Returns

(A) **Site selection:**

In site selection, the following must be considered.

i. **Location:** Location of the farm should not be too far away from the house or town. It should be easily accessible.
ii. **Topography:** Plantain thrives well in a high topography (upland). This is because lowlands and deep fluids bring about plantain hedging.
iii. **Soil type:** The ideal soil for plantain is a light, deep, medium-textured, well-drained, fertile soil with a high-water holding capacity in the pH range of 5.0 – 8.0. The soil should enable roots to develop uninhibited. Heavy soil with poor drainage must be avoided.
iv. **Field management:** Field management is very important because it gives the farmer a fore knowledge of the actual area or size of the farm. The use of Geographic positioning system (OPS) has simplified the rigor of land measurement. Good management practices should be strictly followed.

(B) **Routine Management Practices**

i. **Land Preparation:** Land preparation should include: bush clearing, tree felling for virgin forests. Pegging, spacing and hole digging will go simultaneously.
ii. **Spacing and Inter-cropping:** Recommended spacing is 3x3' or 3x2' between within row. However, wider spacing could be adopted if one wishes to intercrop with short duration crops such as sweet potatoes, groundnuts, okra, maize etc.
iii. **Alley Cropping:** This is a scientific method of maintaining soil fertility and providing appropriate mulching materials for plantains. It involves planting of leguminous shrubs in between the alleys of plantain stands. The alley crops are cut back regularly, and the cutting used as mulch.

(C) **Variety of Seed Selection:**

Five types of planting materials in plantain include:

1. The Water shoots
2. The first swords (peepers)
3. The larger swords (peepers)
4. The maiden (corms)
5. The Buds (corms).

(D) **Climatic requirements:** Temperature 21^{0c} -35^{0c}, Rainfall 1500mm-2200cm per annum. Relative Humidity of 70-75% is adequate for plantain. Plantain can also be grown in areas with low wind storm. Eight months of rainfall will make excellent performance.

(E) **Planting Date, Time and Methods:** The best time to plant plantain suckers is from November to March when the dry season is setting in, so that by the next dry season,

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harvesting will be easy. Spacing can be 3^1 by 3^1 or 3^1 by 2^1. between Planting hole of 60 cm deep is adequate for each sucker. Plant population per hectare is 1,500 or 1,666 stands.

(F) **Soil Management:** It is important to return crop residues or the previous year unto the soil where plantain was harvested. Synthetic fertilization of the soil is also important.

(G) **Water Management:** Naturally, plantain is full of water. So, requires less water to grow. Excess of water could lead to logging of the plant.

(H) **Weed management:** Plantain farm should be slashed every three, six and nine months of establishment.

(I) **Fumigation and pest control:** If herbicides should be used, precautionary measures must be put in place to ensure safe use of pesticides and fungicides. Follow every instruction on the label and only trained personnel should apply the pesticides at recommended rates. The personnel should ensure to wear protective clothes during work.

(J) **Harvesting and processing:** The harvesting should be done when the plantain bunch is fully matured. First cut the pseudostem from half or midway. Smartly, ensure the bunch do not touch or fall to the ground. Then cut off the bunch from the beginning of the stalk. Ripe plantain can be processed into plantain juice etc. unripe plantain can be processed into flour. Harvest timely and when the floods are threatening.

(K) **Marketing and consumption:** Harvested plantains are sold at both local, national and international markets and consumed. While it is fresh green and ripe (yellow). Both types can further be processed into different recipes and consumed. E.g., plantain bread, plantain eggroll, plantain meat-pie, plantain chips etc.

(L) **Maturity and yield:** Maturity starts from 8-9 months. fruiting takes between 2-3 months. Yield is 1,500 -1,666 bunches per hectare. Harvesting is a continuous process, nearly every month for four to five years.

Plantain Suckers Multiplication Techniques

(A) **Types of Multiplication**

Plantain sucker multiplication techniques have two types/methods

1. **Decapitation Technique:** This is stimulating the lateral bud by destroying the active growing point. That is, meristem in the pseudostem.
2. **Corm technique:** This involves the excision of the corm. That is, corms from flowering lodged and harvested plants can be used for sucker multiplication. The corm is split with a sharp knife or matchet into many pieces of 10, 20 or 30 setts. It is proper to source for good quality and high yielding sucker producing corms for multiplication. Setts should be weighing about 100 or 150gm depending on the size of the corm. Cut off the large white endosperm. So that the size and weight is not too big or heavy.

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(B) **Curing of setts:**

Treat or cure setts with germicides, nematicides, insecticides, etc, before establishing on the nursery bed at 25cm × 25cm within and between rows. Treat setts with Marshall 2% dust, or apron star 500s, or seed plus; or wood ash in a small water solution. Wash setts or bits with Benlate solution and air-dry under shade for 24hours before planting. (Onuh et al, 2008)

(C) **Nursery Beds:**

Sprouting of the setts or bits is expected to commence between 2-4weeks after planting. The sprouted bits are transferred to polybags filled with rich black earth and allowed to develop to about four-leaf stage before being transferred to the main farm or sold for field planting.

(D) **Plantain Bunch Types**

Basically, there are three types of plantain bunches. They include: (1) The French type, (2) The horn type, and (3) The false horn type. (Swennen, 2000).

1. French Type: This bunch is with many compartments. Has the female, neutral and male parts.
2. The Horn Type: This bunch has one to three components only. Female fluorescence only. No neutral flowers. No male flowers.
3. The False Horn Type: This bunch has two to seven compartments. Female and neutral flowers only. No male flowers. Different taste

(E) **Nursery Bed Preparation:**

Prepare your nursery by clearing the bush, till the soil, and peg out the spacing. Mix clay soil with sand or saw dust treated with furadan (insecticide/nematicide). Setts shall remain for 2-3months in the nursery. Thereafter, seedlings can be transferred to the main farm land. Your nursery can be in a Green House. (FAO STAT, 2011).

(F) **Transplanting: (Spacing and Plant Population):**

Transplant from nursery to main farm land of one hectare measuring 100m × 100m (or 21plots) at a plant spacing of $3\times3m^2$ or $3\times2m^2$. Plant population will be 1,500 or 1,666 stands.

(G) **Thinning or Desuckering**

Thinning should be carried out to prevent overcrowding, and competition between the suckers and the mother plant. It is proper to thin one or two follower suckers per stand.

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(H) **Establishment of a Plantain Farm**

After land preparation, suckers are transferred from the nursery bed to the main land when they are two to three months old. Fell all the trees after planting, cut down all the big trees and palm trees. When you plant and fell the trees, the impact of the fall of the trees to the ground causes the land to vibrate and produce rapid growth of the plant materials.

(I) **Fertilizer Application**

Repeat slashing or chemical weeding at 2-3months and 6-9months. Apply NPK 15:15:15 fertilizer at 3 and 6months. This will allow for adequate soil nutrients. Others are, sulphate of ammonia, super sulphate, and muriate of potash at the rate of 380kg/ho. Organic manure such as compost, poultry or household wastes can be used.

(J) **Pruning and Mulching**

Perform pruning and mulching early. The importance of prunning includes; (1) Regular and Early fruiting (2) Remove over crowded suckers (3) Reducing transpiration, (4) increases fruit size and bunch size. Pruning is a Phyto-sanitary measure. Similarly, mulching helps to cool the base of the plantain stand, enrich the soil and prevent evaporation. Plantain performs best under mulch.

Biology of Plantain Plant

1. **The Stem:** Plantains are the world's largest herb. Scientifically, they do not have a typical solid, wooden trunk that would identify them as trees. Instead, they have a pseudostem made up of layers of leaves furled around one another to form a stem that is as thick as 12 inches and as tall as 40feet. One advantage of plantain is that they can be used as a reliable source of nutrient all year round. (FDAFS, 2005). The mid-rib of the pseudo stem is eaten by both ruminant and non-ruminant animals. It is a delicacy for the snails. (FAO, 2016)
2. **The Roots:** Plantain is made up of the fibrous root system. In traditional medicine, the roots are used to correct erectile dysfunction and many other medical conditions.
3. **The Leaves:** Plantain leaves are large and oval in shape. The leaves can be 8ft long and 2ft wide. The leaves have been used to treat malaria, fever, diabetes, coccidiosis, tonsillitis, etc. it is also used to wrap foods like moimoi, okpa etc. The leaves are the main basis for photosynthesis. It is also used as roofing materials in farm houses. (Callees et al, 2000)
4. **The Fruits:** The fruits provide the vital nutrients (carbohydrates and protein), vitamins and minerals for the proper development of man and animals.

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5. **The Flowers (Florescence):** This perennial plant produces greenish flowers. Those flowers serve as the region for pollination and fertilization. In some large plantation, bees have produced "mono-flora honey" because all the nectaries used for the production of the honey came from only plantain.

Biological Value of Plantain

The biological/nutrition values of plantain as a feed resource is very rich. The biological value (BV) of plantain is water (70.0%), carbohydrate (50.1%), protein (5.5%), fat (0.3%), Fibre (5.8%), minerals (0.8%). Culible value is: 100.00g.

Minerals include: Iron (15%), Calcium (2%), phosphorus (15%), Zinc (2%), potassium (2.5%), copper (9%), Magnesium (30%), selenium (3%).

Vitamins are: Vitamin B (2%) and Vit. C. Calorific value is 136.

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Many uses of Plantain

Plantain is eaten as a staple food in Nigeria. It is processed (dried) and blended into plantain flour, it can be turned into foofoo or plantain pap. The unripe fruits are peeled and the endosperm cooked and eaten. The ripe fruits are fried and eaten as dodo. It can be eaten with beans as pottage.

The fruit, leaves and endosperm of Musa can be used as feed ingredients in the diets of poultry and livestock. (Ajasin et al, 2004), (Akande and Agbatery, 2019), and (Taylor et al, 2010).

In the Niger Delta region of Southern Nigeria, plantain is eaten as plantain pepper soup. Plantain is roasted and eaten with roasted fish as Bolle. It is a special delicacy in Bayelsa State, Nigeria.

Again, plantain is used to prepare plantain pottage. It is sometimes called kekefiyai (or K.K.F). It is the hottest delicacy in Bayelsa State. Plantain can be used to bake bread, meat pie, egg roll, sausage, etc. (Kainga, 2013).

Untapped and Underutilized Business Potentials in Plantain

From plantain farming and plantain, the following business enterprises can be identified. There are many untapped and under-utilized business potentials in plantain. (Allison-Oguru et al, 2008). Some of them are;

1. Sales of only the ripe and/or unripe plantain.
2. Processing of plantains to plantain flours.
3. Production of plantain foofoo: This can be processed and taken to the open market, and supplied to food restaurants and hospitals. It is good for the elderly and diabetic patients.
4. Plantain sucker multiplication as an agro business providing farm inputs to prospective plantain farmers.
5. Livestock Feed: Plantain fruits, leaves, peels, pseudostems, are used to compound poultry and livestock feeds and feed additives herbal drugs.
6. Confectionary Section: Plantain has been used by the confectionary unit to produce plantain bread, meat pie, egg roll, chin-chin, bunce, etc.
7. Textile Industry: Every part of the plantain and by-products is very useful. The textile industry use the pseudostem, meistem, stalk, peels and flours for various materials like carpet, thread, weavon, hats, shoes, mat, rug, bags, table cloth, threads etc.

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8. Pharmaceutical Industry: Different pharmaceutical industries have used different parts of plantain to come up with different forms of drugs in the form of syrups, tablets and nutraceuticals.
9. It is thought of that there are different untapped business potentials and under-utilized forms of plantain roots, stems, leaves, fruits and flowers. It is believed that with uncountable research works that are going on, many more facts will soon emerge concerning plantain.

Pests and Diseases in Plantain

Allison-Oguru et al (2008), reported that Musa paradisiaca production suffers between 17-20% losses from fungal, bacterial and viral diseases.

A. Pests of Plantain:

1. Eelworm (Rhodapholus similis): It attacks the roots of plantain thereby creating galls in the roots.
2. Plantain borer: The larvae of this insect bore holes into the corm of the plant.
3. Bats: They eat up the ripe fruits.
4. Monkeys: They also eat up the plantain fruits.

Control of Plantain Pests:

The following methods can be applied to control plantain pests. Set traps on the farm; uproot and burn infected parts. Treat planting materials with chemicals, like nematicides. E.g. Aldrin or Dieldrin. Treat one to four hours before planting and finally, early harvesting of fruit is important.

B. Diseases of Plantain

- **Fungal diseases of Plantain**

i. **Panama Diseases:**
Causative Organism: Fusarium Oxysporum.
Transmission: Through fungal hyphae in the soil tissues.
Symptoms: Affects the whole vascular system, leaves wither, petroles collapse, and the leaves turn yellow.
Control: Use only healthy plant materials/suckers, spray with funjicides.

ii. **Black sigatoka Disease (Leaf Spot):**
Causative Organism: Carcospora mycosiphaerella.
Transmission: Through rain drops on the leaves

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Symptoms: Yellow spots which later turn grey at the centre. Brown spots may form parallel band to the lateral veins.
Control: Spray with Bordeus mixture (a fungicide)

- **Bacterial Diseases of Plantain**

i. **Bacterial Blight**
Causative Organism: Bacteria spp.
Transmission: Contaminated leaves and planting materials. Also, by water or rainfall.
Symptoms: Brown spots develop on the leaves.
Control: Use healthy materials when planting. Treat before planting.

- **Viral Diseases of Plantain**

i. **Bunchy Top Disease**
Causative Organism. Virus
Transmission: Piercing and Sucking insects.
Symptoms: Stunted growth, crowded leaves, leaves develop curled edges.
Control: Burn and bury infected plants.
Practice food Sanitation. Dig into the soil to pull out infected plant.

Economic Importance of Pests and diseases of Plantains.

Economics of pests and diseases of Musa production to the practitioner includes the following:
Reduces farm revenue.
Reduces crop quality
Reduces crop yield

- **Starting a Plantain Farm: Requirements for one Hectare of Land.**

(A Proposal)

A. **<u>Fixed Assets:</u>** land (21 plots)

- (Family land)(Token payment) = 200,000.00
- Cassava Grinding Machine (mini mill) = 200,000.00
- Wheel Barrow (2) = 100,000.00
- Head Pan(4) = 40,000..00
- Knapsack Sprayer (1) = 60,000.00
- Spade (4) = 20,000.00
- Machetes (4) = 20,000.00
- Blender (1) = 80,000.00

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- Transport = 100,000.00
- Miscellaneous = 130,000.00

TOTAL =

1,000,000.00

B. Current Assets:

- Land Preparation = 100,000.00
- Plantain Suckers = 250,000.00
- Insecticides/Herbicides/Fungicides = 60,000.00
- Labor (4 persons) = 100,000.00
- Thinning, pruning, Mulching = 50,000.00
- Fertilizers (4 bags) = 100.000.00
- Fertilizers' application/staking = 50,000.00
- Protective wears = 100,000.00
- Harvesting and carrying = 50,000.00
- Transport = 100,000.00
- Miscellaneous = 100,000.00

TOTAL =

1,000,000.00

Project Cost and Project Revenue

1. **Project cost:**
   1,000,000.00
2. **Project Revenue:**
   3,960,000.00
3. **Project Profit:**
   3,960,000.00
   -2,000,000.00
   1,960,000.00
   Only a Guide

Summary

Plantain farming or business enterprise can be very profitable, if 1,666 stands were planted and 1,500 fruits were harvested. Then 133 dozen will sell at 133x₦60,000 is = ₦7,650,000. Thus, if you invested ₦2,000,000 into the business, profit will be Total Revenue minus Total cost. That is ₦7,650,000.00 -₦2,000,000.00. Profit will be: ₦5,650,000.00 only.

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Conclusion

Plantain is the cheapest staple crop to produce compared to other food crops like maize and cassava. It provides high economic returns and reaches maturity and pays off the cost of establishment within a year. It provides food security and gainful employment to both urban and rural dwellers. Plantain has been identified as a verifiable strategy for alleviation of poverty and hunger.

There is paucity of information on Musa paradisiaca Production. This book chapter aimed at presenting a full text and practical guide on Musa production.

Recommendations

Musa paradisiaca as potential feed resource should be used for all livestock feeding. Musa is still highly under-utilized as a business resort for the industry. Further research should be made into its use in other industries.

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