Name of Principal Investigator, Phone No. and Email Address

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i. Title of Proposal

STARTUP OFA PILOT PLANT FOR THE PRODUCTION OF BAGGED PLANTAIN FLOUR FROM UNRIPE PLANTAIN USING THE DEVELOPED PLANTAIN PROCESSING PLANT IN FUTA

ii. Executive Summary

Food is a nutritional support substance needed by the body to keep it alive for life and social functionalities. The state of man's health is a function of what he consumes. This, therefore, requires a call for caution to do away with food not hygienically produced that are dangerous to human health. Nigeria's ecological and climatic conditions put the country at an advantage for the production of a wide range of food products such as plantain if properly processed and packaged. The categories of foods most useful and healthy to the body are fruits and green vegetables. However, these are seasonal and perishable in nature as greater percentages are being wasted due to lack of storage facilities. Food losses to poor handling and low value-adding processing technologies have been of great concern and challenge to food production. These call for greater attention if food security is to be sustained. Value addition processes stand to be the sine-qua-non to the preservation of agricultural fruit wastages during the season of its abundance. Plantain, the fourth most important crop, is crucial to the food security and livelihoods of many people in Nigeria – the fifth leading plantain producer in the world. Plantain has become an important source of healthy food in the Nigerian market today, as it is used in managing diabetes. As a result, it is quickly becoming a sought-after fruit for everyone. The demand for plantain flour is rapidly increasing due to its health/nutritional benefits and industrial/commercial value. Plantain postharvest losses in Nigeria typically range from 5% to more than 50%. Because plantain is perishable, it is typically processed into flour to extend its shelf life, during which contamination or exposure to an unhealthy condition may occur.

Team of Researchers from different departments at the Federal University of Technology, Akure, comprising experts with a good track record from the field of Mechanical Engineering, Industrial and Production Engineering, Electrical and Control Engineering, Mechatronics Engineering, Food Science and Storage Technology, had been able to proffer solution to this problem by developing an indigenous process plant for processing unripe plantain fingers into bagged flour which consists of seven sections: washing, particulating, drying, milling, conveying-cooling, metering and packaging, so arranged to form C or U-shape in order to conserve floor space (see Figures 1 and 2). This invention is a plant for processing unripe

plantain fingers into bagged flour (see Figure 3). It established procedures for developing a plant that can continuously produce flour from unripe plantain fingers and other similar crops. The invention can be used as a model for a methodical approach to developing indigenous food processing plants. By this invention, the unit machine and manual processing of plantain have been eliminated resulting in the production of hygienically packaged plantain flour that retains the flavor, esteem, and nutritional values of fresh plantain in the flour produced. Other food supplements already developed at the Food Science Technology Department of the Federal University of Technology, Akure can be added to the plantain flour during production to fortify it for other health benefits. The plant has the capacity to produce 1000 kg of flour per day, it requires 12 m by 6 m (72 m^2) of floor space, and the cost of production as at year 2021 is Sixty million naira only (₦60,000,000). The plantain flour plant was indigenously designed and fabricated at the Federal University of Technology, Akure. It has already been patented. There are over fourteen (14) academic publications in standard journals and conferences from the work and eight (8) postgraduate students have been produced during the course of the work.

A sum of **One Hundred and Ninety Six Million, Seven Hundred and Five Thousand Naira (₦196,705,000.00)** is estimated as the amount needed to startup the production of plantain flour from this plantain flour plant that was indigenously designed and fabricated at the Federal University of Technology, Akure partly through the Institutional Based Research (IBR) grant. The detail of the business case for the production of FUTA plantain flour comprising overview, startup budget, cost of goods and services, income, expenses, revenue, labour, and projection are as shown in Table 1 to Table 8.

This project will have a direct impact by delivering wholesome bagged flour to the citizenry; reduction in-post-harvest losses as agricultural produce can instantly be processed for future use thus, increasing food security; promote industrialization; create jobs; and promote small and medium enterprises (SMEs) in Nigeria.

iii. Background to the Research

Nigeria's wealth of knowledge in home-grown technologies for value addition to agricultural produces calls for upgrading and transformation enhancement in meeting local demand, promoting food security, reducing post-harvest losses, and improving external trade economy. Machines automation, is a contemporary technology which is meant to enhance agricultural raw materials processing by timely transforming it to end product(s) which are safe, healthy and hygienic as the processing is void of human handlings. Plantain, the fourth most important crop, is crucial to the food security and livelihoods of many people in Nigeria – the fifth leading plantain producer in the world. Plantain has become an important source of healthy food in the Nigerian market today, as it is used in managing diabetes. As a result, it is

quickly becoming a sought-after fruit for everyone. The demand for plantain flour is rapidly increasing due to its health/nutritional benefits and industrial/commercial value. Plantain postharvest losses in Nigeria typically range from 5% to more than 50%. Because plantain is perishable, it is typically processed into flour to extend its shelf life, during which contamination or exposure to an unhealthy condition may occur. Moreover, there are only batch production unit machines available, which do not allow for continuous flour production. The available unit machines do not have provision for constant turning of plantain during drying. Some of the available methods of processing plantain into flour are labor-intensive, time-consuming, and unsanitary, as they harbor microorganisms and toxic constituents that affect the quality and nutritional value of the flour produced. It is therefore necessary to increase the quantity and quality of the flour produced from the crop; hence, the need for a plantain flour production and packaging plant, which is key to Goals 1 and 2 of the Sustainable Development Goals (SDG) of the United Nations. Management of type 2 diabetes, mitigation of alarming postharvest plantain losses, food security enhancement, curbing gluts and price instability, value addition, market diversification, job creation/improvement of livelihoods, etc. motivated this project. As a result, a bagged plantain flour processing plant from unripe plantain was developed 100% at the Federal University of Technology, Akure. The need to take this invention to the market to enhance food security, and promote SMEs in Nigeria necessitate this proposal.

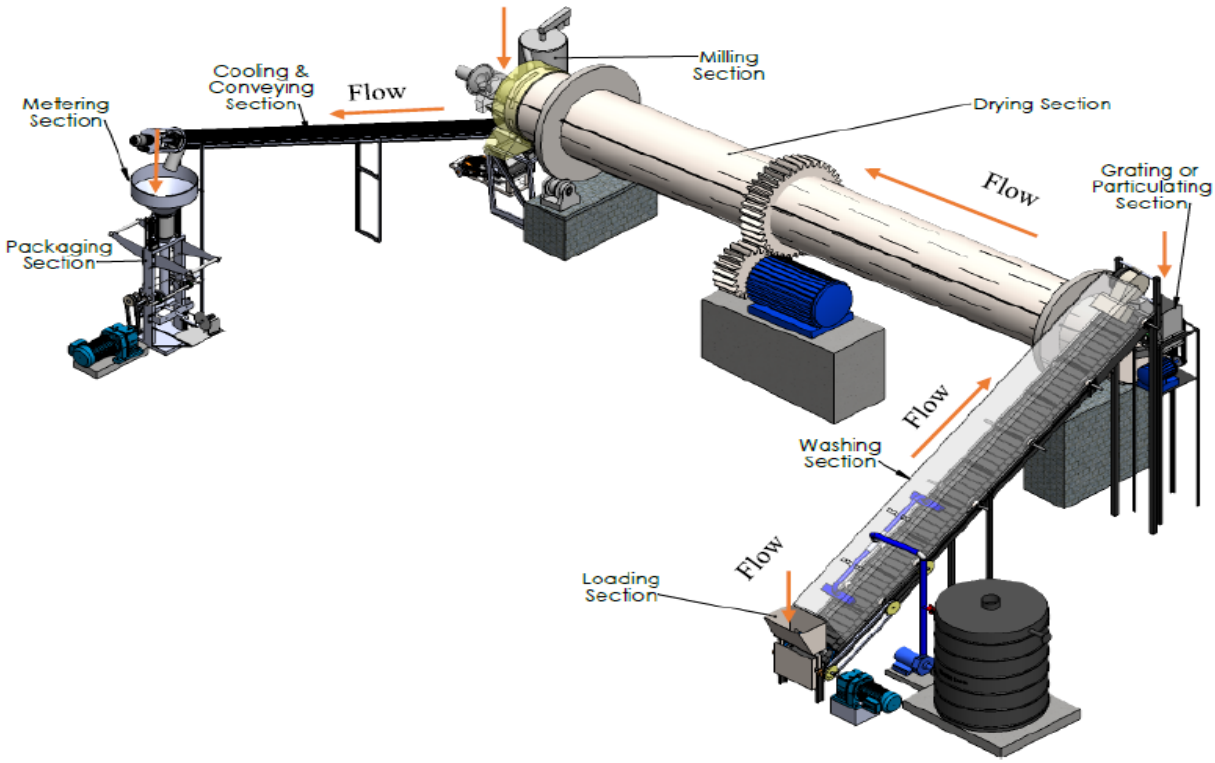

Figure 1: Isometric View of the Plantain Processing Plant Assembly

Figure 2: Picture of the Plantain Processing Plant Prototype

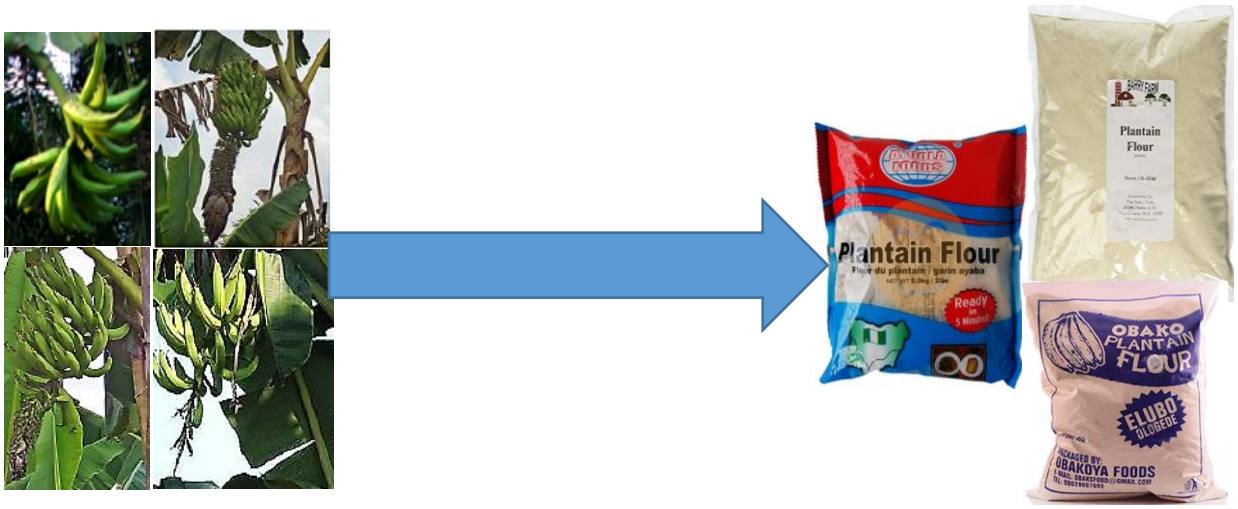

Figure 1. Unripe Plantain Conversion into Flour is Our Goal

iv. Objectives of the Research

The general objective of this proposal is to operationalize the developed plantain process plant for future commercialization of it mass production.

The specific objectives of the study are to:

1. set up FUTA plantain flour production factory as a model;
2. produce functional foods;
3. train students on 100% locally made processing machines and factory;
4. provide opportunity for entrepreneurial skill acquisition and job opportunity for students to complement effort of government to support students school fees; and
5. serve as a means of income generation for the institution.

v. Research Questions

1. can the processing plant add value to other agricultural produces or serve as an alternative processing plant?
2. what nutritional advantage and stock-to-output efficiency does the process plant has over the traditional processing route?
3. what are the impacts of processing units' settings of the plant on the product's quality and shelf life?
4. Will the setting up of the factory have significant impact on the students, university and the society at large?

vi. Expected Results

The proposal is expected to:

i. deliver sustainable pilot plant for the production of bagged plantain flour from unripe plantain using the developed plantain processing plant in FUTA;
ii. provide value addition, quality and food safety to indigenously processed plantain flour;
iii. lead to reduction in-post-harvest losses, thus, increasing food security;
iv. promote industrialization and jobs creation; and
v. produce well-trained students on 100% locally made processing machines and factory set up

vii. Estimated Budget

Proposed Budget Summary ₦196,705,000.00

A sum of One Hundred and Ninety Six Million, Seven Hundred and Five Thousand Naira (₦196,705,000.00) is estimated as the amount needed to startup the production of plantain flour from the plantain flour plant that was indigenously designed and fabricated at the Federal University of Technology, Akure.

Table 1: Business Case Overview for Plantain Flour Production

INCOME STATEMENT	Year 1	Year 2	Year 3
Sales revenue	405,000,000.00	472,500,000.00	472,500,000.00
Cost of goods & services (COGS)	72,900,000.00	72,900,000.00	72,900,000.00
Gross profit	332,100,000.00	399,600,000.00	399,600,000.00
Gross margin	82%	85%	85%
Operating Costs			
Marketing & Sales	3,600,000.00	3,600,000.00	3,600,000.00
Wages	1,440,000.00	1,440,000.00	1,440,000.00
Utilities	2,160,000.00	2,160,000.00	2,160,000.00
Rent/Infrastructure/maintenance	6,700,000.00	7,000,000.00	7,500,000.00
Subscription	120,000.00	120,000.00	120,000.00
General & Administration	3,500,000.00	3,500,000.00	3,500,000.00
Travels	0.00	0.00	0.00
Total	**17,520,000.00**	**17,820,000.00**	**18,320,000.00**
Operating profit	314,580,000.00	381,780,000.00	381,280,000.00
Operating margin	78%	81%	81%
less interest	0	0	
Pretax income	314,580,000.00	381,780,000.00	381,280,000.00
Income tax (7.5%)	23,593,500.00	28,633,500.00	28,596,000.00
Net income	**290,986,500.00**	**353,146,500.00**	**352,684,000.00**

Table 2: Startup Budget for Plantain Flour Production

Fixed cost			
Variable cost			
Items	**Quantity Per Monthly**	**Unit Cost (₦)**	**Total (₦)**
Marketing & Sales	12	300,000.00	3,600,000.00
Wages	12	120,000.00	1,440,000.00
Utilities	12	180000.00	2,160,000.00
Raw/fresh plantain (25 tons monthly)	300	70,000.00	21,000,000.00
Accessories and other consumables	12	50,000.00	600,000.00
Packaging (11250 kg monthly)	145,000	300.00	43,500,000.00
General Administration (G&A)	12	100,000.00	1,200,000.00
Rent			0
Subtotal			**₦73,500,000.00**
ONE TIME COSTS	**Amount**		
Machinery installation		15,770,000.00	15,770,000.00
Toyota Hilux 2024 model	1	97,515,000.00	97,515,000.00
NAFDAC approval		250,000.00	250,000.00
Domain name/Incorporation fees		170,000.00	170,000.00
30kVA Generator	1	9,500,000.00	9,500,000.00
Subtotal			**₦123,205,000.00**
STARTUP COST			**₦196,705,000.00**

Table 3: Cost of Goods and Services for Plantain Flour Production

1st Month Projection

Items	No. of Months	Qty	Amount	Total
Raw/fresh plantain (bunches)	2 Weeks	2500	4,500.00	11,250,000.00
Labour (2)	1	1	90000	90,000.00
Packaging (11250 kg monthly)	1	11250	200	2,250,000.00
Total				13,590,000.00
		A MONTH PROJECTION		

Table 4: Cost of Goods and Services for Plantain Flour Production

1st Year Projection

Items	No. of Months	Qty	Amount	Total
Raw/fresh plantain(25 tons monthly)	12	24000	3,500.00	84,000,000.00
Labour (2)	12	12	90000	1,080,000.00
Packaging (11250 kg monthly)	12	135000	200	27,000,000.00
Total				112,080,000.00
		1ST YEAR PROJECTION		

Table 5: Cost of Goods and Services for Plantain Flour Production

2nd Year Projection

Items	No. of Months	Qty	Amount	Total
Raw/fresh plantain(25 tons monthly)	12	24000	3,500.00	84,000,000.00
Labour (2)	12	12	90000	1,080,000.00
Packaging (11250 kg monthly)	12	135000	200	27,000,000.00
Total				112,080,000.00
		2ND YEAR PROJECTION		

Table 6: 1st Month Projected Revenue for Plantain Flour Production

Day/Week	Quantity	Revenue
1st	450	1,350,000.00
2nd	450	1,350,000.00
3rd	450	1,50,000.00
4th	450	1,350,000.00
5th	450	1,350,000.00
6th	450	1,350,000.00
2nd Week	2700	8,100,000.00
3rd Week	2700	8,100,000.00
4th Week	3150	9,450,000.00
		0.00
		0.00
		0.00
Total	11250	33,750,000.00
Unit Price	3,000.00	

Table 7: 1st Year Projected Revenue for Plantain Flour Production

Month	Quantity	Revenue
Jan	11250	39,375,000.00
Feb	11250	39,375,000.00
Mar	11250	39,375,000.00
Apr	11250	39,375,000.00
May	11250	39,375,000.00
Jun	11250	39,375,000.00
Jul	11250	39,375,000.00
Aug	11250	39,375,000.00
Sep	11250	39,375,000.00
Oct	11250	39,375,000.00
Nov	11250	39,375,000.00
Dec	11250	39,375,000.00
Total	135000	472,500,000.00
Unit price	3,500.00	

Table 8: 2nd Year Projected Revenue for Plantain Flour Production

Month	Quantity	Revenue
Jan	11250	39,375,000.00
Feb	11250	39,375,000.00
Mar	11250	39,375,000.00
Apr	11250	39,375,000.00
May	11250	39,375,000.00
Jun	11250	39,375,000.00
Jul	11250	39,375,000.00
Aug	11250	39,375,000.00
Sep	11250	39,375,000.00
Oct	11250	39,375,000.00
Nov	11250	39,375,000.00
Dec	11250	39,375,000.00
Total	135000	472,500,000.00
Unit price	3,500.00	

viii. Research Team (Name/Rank/Highest Qualification/Area of specialization)

A. Principal Investigator/Researcher:

Name: **Prof. S. P. Ayodeji**

Rank: **Professor**

Highest Qualification & Area of Specialization: **PhD, Process & Machine Design and Applied Ergonomic**

B1. Researcher Partner:

Name: **Prof. M. K. Adeyeri**

Rank: **Professor**

Highest Qualification & Area of Specialization: **PhD, Systems Design and Smart Maintenance**

B2. Researcher Partner:

Name: Dr. E. O. Olutomilola

Rank: **Reader (Associate Professor)**

Highest Qualification & Area of Specialization: **PhD, Machine/System Design, and Manufacturing Engr.**

B3. Researcher Partner:

Name: **Prof. A. A. Badejo**

Rank: **Professor**

Highest Qualification & Area of Specialization: **PhD, Food Product Development**

B4. Researcher Partner:

Name: **Prof. J. J. Popoola**

Rank: **Professor**

Highest Qualification & Area of Specialization: **PhD, Communication and Control Engineering**

B5. Researcher Partner:

Name: **Dr. Mrs. I. A. Olajide**

Rank: **Senior Lecturer**

Highest Qualification & Area of Specialization: **PhD, Control and Communication**

C1. *Research Mentees / Young Academics:*

Name: **Engr. O. S. Olasanoye**

Rank: **Lecturer I**

Highest Qualification & Area of Specialization: **M.Eng, Automation and Machine Design**