UNIVERSITI PUTRA MALAYSIA

PRODUCTION RISK AND TECHNICAL EFFICIENCY OF COTTON PRODUCTION IN NORTHEAST ZONE OF NIGERIA

MUHAMMAD BALA

FP 2019 16

PRODUCTION RISK AND TECHNICAL EFFICIENCY OF COTTON PRODUCTION IN NORTHEAST ZONE OF NIGERIA

By

MUHAMMAD BALA

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

November 2018

DEDICATION

Specially dedicated to my beloved
Parents,
Alhaji Muhammad Majidadi
And
Hajiya Maryam Abudullahi Muhammad

Wife,
Hauwa Bala Umar
Children,
Maryam Bala Muhammad
Fatima Bala Muhammad
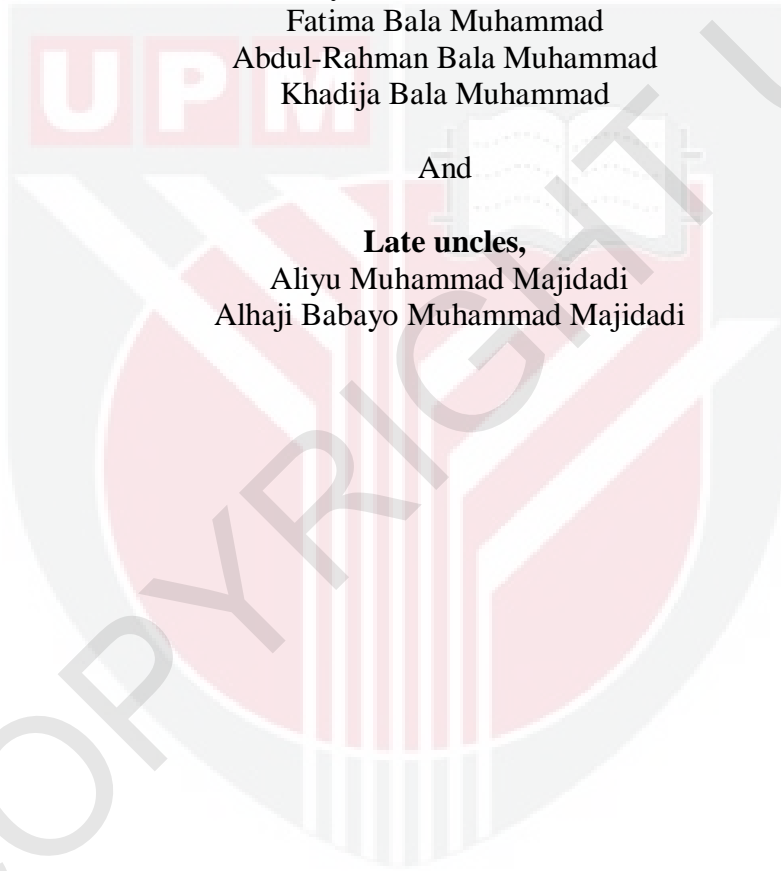Abdul-Rahman Bala Muhammad
Khadija Bala Muhammad

And

Late uncles,
Aliyu Muhammad Majidadi
Alhaji Babayo Muhammad Majidadi

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

PRODUCTION RISK AND TECHNICAL EFFICIENCY OF COTTON PRODUCTION IN NORTHEAST ZONE OF NIGERIA

By

MUHAMMAD BALA

November 2018

Chairman : **Professor Mad Nasir b Shamsudin, PhD**
Faculty : **Agriculture**

Cotton is among the major cash crop and of considerable importance to Nigeria. Despite the importance of cotton in the nation's economy, the actual cotton yield in the country was low as its fall within the range of 0.4-0.5 t/ha, compared to the genetic yield range of 2.5-3.0 t/ha in the country, Ogunlela (2004). Cotton farming in Nigeria is naturally operated with risk that mostly emanated from weeds, pests, diseases, inadequate supply of seed quantity, lack of financial backing of the extension staff by the government on the enlightenment of the farmers on how to adapt the modern farming system. other constrains includes low yield that emanated from low-quality seeds, high cost of production and lack of strict adherence to good agronomic practices by the farmers, unable to have access to credit and their inability to farm efficiently, as identified by previous studies Ogunlela (2004).

Research has shown that the varieties grown and the yield attainable is between 1.5-2.5 t/ha contributes to the decline and fluctuation in farmers' productivity due to increasing rate of diseases, pests and soil fertility. This caused uncertainties in every cropping season of production and has to be examined through the choices of model that shows the effect of inputs on the output variance called production risk in inputs. With the realization of output that is uncertain, the ability of farmers to obtain maximum yield given the set of input factors influenced by their input's decision as well as environmental factors will be achieved. Though some input factors may contribute positively to the realization farmer's output, factors that are related to environments such as the incidence of pests and diseases, drought and floods affect the ability of farmers to obtain high yields ultimately.

i

Therefore, the main objective of this study is to determine the production risk and technical efficiency of cotton production in the North-east Zone, Nigeria by engaging the stochastic frontier model with flexible risk specifications, sampling 349 cotton producers in the study area, in an effort to properly understand cotton production technique. The variation of technical inefficiency is explained by the following determinants: 1) demographic socioeconomic and farm characteristics; 2) agricultural extension characteristic; and 3) environmental characteristics. On the other hand, the specific objectives of this study were to: i) determine the production risk behavior with respect to farmers' inputs; ii) determine the technical efficiency with respect to farmers' inputs; iii) compare farmers' technical efficiency using DEA and SFA; and to iv) determine the factors affecting the technical efficiency of cotton farmers.

Consequently, the study models technical efficiency with production risk in inputs use as two (2) possible sources of production variability that characterized cotton production in the study area. Data from 349 cotton farmers that are randomly selected from three (3) different states in the study area were used for the analysis which was sourced from the survey conducted for the period of 2016 farming season. The study employed a trans-log stochastic frontier production function model with flexible risk specification. The empirical estimates revealed that the mean output is positively influenced the variable inputs (seed, fertilizer, agrochemicals and labour). Seed, fertilizer, agrochemicals are found to be risk-reducing inputs, while labour is risk-increasing inputs. By implication, it shows that the risk-averse farmer is expected to use more seed, fertilizer and agrochemicals and less labour compared to risk-neutral farmer in the study area. Several characteristics of demographic data like age, education, marital status household size, farming experience, off farm activities, extension visit and credit access were found to have significant effects on technical inefficiency of the cotton farmers in the study area. The estimated technical efficiency indicates that the efficiency score is overstated when the production of cotton farms is modelled without flexible risk component (88.3 percent) while it was found when estimated with risk component to be 83.7 percent. Technical efficiency of cotton farmers in the study area was also compared between DEA and SFA. The result revealed that the average efficiency score of SFA 91 percent implies that, although farmers in the study area are technically efficient. On the other hand, the result of DEA technical efficiency score is 78 percent, meaning that the cotton farmers in the study area are technically efficient in their production. The study concludes that the trans-log production function model is the best fit for the data for the estimation of farmers' technical efficiency as the analysis recorded that technical efficiency enhances the variability of cotton production in the study area.

Though the model estimates display that production risk contributes considerably to the vitality of cotton production, findings of this research work also shows that output variability is primarily explained by technical inefficiency and production risk. The present study authenticates that there is a needs to extend the theoretical framework for investigating technical efficiency because of the uncertainty that was associated with production processes, generally link production risk with the persistent uncertainty. The estimation of technical efficiency of cotton farms in Nigeria, however, under the assumption of risk neutrality with respect to production risk in

ii

inputs, has fundamentally combine biased estimates of the technical efficiency of the farms. Apparently, such estimate might lead to misleading policy recommendations judging from the results of this study.

The deviation in output as a result of technical inefficiency are more pronounced than the deviation in output as a result of the pure noise component in output, as explained by the lambda value of (3.4937). The combined effects of farm inefficiency factors are able to explain variation in technical efficiency although some individual variables are not significant. The conventional input factors such as, seed, fertilizer, agrochemicals and labour are essential in the development of cotton production as they increase mean output positively in the production process. The production behaviour as characterized by cotton farmers in the study area display decreasing return to scale (0.533). Seed, fertilizer and agrochemicals are risk reducing variable inputs. Therefore, these variables can be used to alleviate the effect of risk in the production process.

The mean technical efficiency for the surveyed using stochastic frontier analysis is 91.34 percent. Cotton farmers in Taraba State are more efficient than their counterpart in Adamawa and Gombe States. Cotton producers that are more educative have access to credit but less efficient. Other factors like farming experience, extension contact, farmers' age and marital status have positive effect on farmers' technical efficiency in the study area. On the other hand, household size and off farm activities diminishes farmers' technical efficiency. Cotton farmers in the study area should be encouraged to consider the demographic data like access to credit, farming experience, educational status very vital activities as they help in increasing their technical efficiency, hence their living standard. It is recommended that government should ease the accessibility to credit and to enlighten the farmers on its advantages towards boosting their livelihood. Consequently, the role of adopting high yield variety in improving cotton seeds that not only reduces the level of inefficiency, production risk and increases efficiency among cotton farmers should be equally encouraged.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

RISIKO PENGELUARAN DAN KECEKAPAN TEKNIKAL PENGELUARAN KAPAS DI ZON TIMUR LAUT NIGERIA

Oleh

MUHAMMAD BALA

November 2018

Pengerusi   : **Profesor Mad Nasir b Shamsudin, PhD**
Fakulti   : **Pertanian**

Kapas adalah antara tanaman tunai utama dan sangat penting untuk Nigeria. Walaupun kapas penting kepada ekonomi negara, hasil kapas sebenar di negara ini rendah kerana kejatuhannya dalam lingkungan 0.4-0.5t/ha berbanding dengan hasil genetik dalam lingkungan 2.5-3.0t/ha di negara ini, Ogunlela (2004). Perladangan kapas di Nigeria secara semulajadi dikendalikan dengan risiko yang kebanyakannya berasal daripada rumpai, perosak, penyakit, bekalan kuantiti bjii benih yang tidak mencukupi, kekurangan bantuan kewangan oleh kakitangan lanjutan kerajaan terutamanya mengenai cara menyesuaikan petani dengan sistem pertanian moden. Kekangan lain termasuk hasil yang rendah yang dihasilkan daripada benih berkualiti rendah, pengeluaran tinggi dan kurang mematuhi amalan agronomi yang baik oleh petani, tidak dapat mengakses kredit dan ketidakupayaan mereka untuk menguruskan ladang dengan cekap, seperti yang telah dikenalpasti oleh kajian sebelumnya Ogunlela (2004).

Kajian telah menunjukkan bahawa varieti yang ditanam dan hasil yang dicapai adalah di antara 1.5-2.5t/ha menyumbang kepada kemerosotan dan turun naik dalam produktiviti petani akibat peningkatan kadar penyakit, perosak dan kesuburan tanah. Ini menyebabkan ketidakpastian dalam setiap musim penanaman dan perlu diperiksa melalui pilihan model yang menunjukkan kesan input pada varians output yang disebut risiko pengeluaran dalam input. Dengan menyedari output adalah tidak pasti, keupayaan petani mendapatkan hasil maksimum berdasarkan satu set faktor input dipengaruhi oleh keputusan memilih input dan juga faktor persekitaran akan dicapai. Walaupun beberapa faktor input dapat menyumbang secara positif kepada output petani, faktor-faktor yang berkaitan dengan persekitaran seperti serangan perosak dan penyakit, kemarau dan banjir memberi kesan keupayaan petani untuk mendapatkan hasil yang tinggi pada akhirnya.

iv

Oleh itu, objektif utama kajian ini adalah untuk menentukan risiko pengeluaran dan kecekapan teknikal pengeluaran kapas di Zon Timur Laut, Nigeria dengan menggunakan model *stochastic frontier* dengan spesifikasi risiko yang fleksibel, melibatkan 349 pengeluar kapas di kawasan kajian, dalam usaha untuk memahami teknik pengeluaran kapas dengan betul. Variasi ketidakcekapan teknikal dijelaskan oleh penentu berikut: 1) ciri-ciri sosioekonomi demografi dan ladang; 2) ciri lanjutan pertanian; dan 3) ciri alam sekitar. Selain itu, objektif objektif kajian ini adalah untuk: i) menentukan tingkah laku risiko pengeluaran berkaitan dengan input petani; ii) menentukan kecekapan teknikal berkenaan dengan input petani; iii) membandingkan kecekapan teknikal petani dengan menggunakan DEA dan SFA; dan iv) menentukan faktor-faktor yang mempengaruhi kecekapan teknikal petani kapas.

Oleh itu, model kajian kecekapan teknikal dengan risiko pengeluaran dalam input digunakan sebagai dua (2) sumber kemungkinan pembolehubah pengeluaran yang mencirikan pengeluaran kapas di kawasan kajian. Data daripada 349 petani kapas yang dipilih secara rawak dari tiga (3) negeri yang berlainan di kawasan kajian dan digunakan untuk analisis kajian yang dijalankan untuk tempoh musim pertanian tahun 2016. Kajian ini menggunakan model fungsi pengeluaran sempadan stokastik trans-log dengan spesifikasi risiko yang fleksibel. Anggaran empirikal menunjukkan bahawa output min secara positif dipengaruhi input pembolehubah (benih, baja, agrochemicals dan buruh). Benih, baja, agrokimia didapati merupakan input mengurangkan risiko, manakala buruh adalah input yang berisiko tinggi. Dengan implikasi, ia menunjukkan bahawa petani yang menolak risiko dijangka menggunakan benih, baja dan agrokimia yang lebih banyak dan kurang buruh berbanding dengan petani yang berisiko neutral di kawasan kajian. Beberapa ciri-ciri data demografi seperti umur, pendidikan, saiz isi rumah, status perkahwinan, pengalaman pertanian, aktiviti di luar ladang, lawatan agen lanjutan dan akses kredit didapati mempunyai kesan yang signifikan terhadap ketidakcekapan teknikal petani kapas di kawasan kajian. Kecekapan teknikal yang dianggarkan menunjukkan bahawa skor kecekapan dinilaikan lebih apabila pengeluaran ladang kapas dimodelkan tanpa komponen risiko yang fleksibel (88.3 peratus) manakala didapati apabila dikira dengan komponen risiko ianya menjadi 83.7 peratus. Kecekapan teknikal petani kapas di kawasan kajian juga dibandingkan antara DEA dan SFA. Hasilnya menunjukkan bahawa skor kecekapan purata SFA adalah 91 peratus, walaupun petani di kawasan kajian secara teknikalnya adalah cekap. Sebaliknya, hasil skor kecekapan teknikal DEA adalah 78 peratus, bermakna petani kapas di kawasan kajian adalah efisyen secara teknikal di dalam pengeluaran mereka. Kajian ini menyimpulkan bahawa model fungsi pengeluaran trans log adalah yang paling sesuai untuk data ini dalam menganggar kecekapan teknikal petani kerana analisis mencatatkan bahawa kecekapan teknikal meningkatkan kebolehubahan pengeluaran kapas di kawasan kajian.

Walaupun anggaran model menunjukkan bahawa risiko pengeluaran menyumbang dengan ketara kepada daya pengeluaran kapas, dapatan kajian ini juga menunjukkan bahawa output boleh berubah terutamanya disebabkan oleh ketidakcekapan teknikal dan risiko pengeluaran. Kajian ini mengesahkan bahawa terdapat keperluan untuk memperluaskan rangka kerja teori untuk menyiasat kecekapan teknikal kerana ketidakpastian yang dikaitkan dengan proses pengeluaran, secara umumnya

menghubungkan risiko pengeluaran dengan ketidakpastian yang berterusan. Anggaran kecekapan teknikal ladang kapas di Nigeria, bagaimanapun, di bawah anggapan risiko neutral berkenaan dengan risiko pengeluaran dalam input, secara asasnya menggabungkan anggaran berat sebelah kecekapan teknikal ladang-ladang. Ternyata, perkiraan itu mungkin membawa kepada cadangan-cadangan dasar yang mengelirukan berdasarkan kepada daripada hasil kajian ini.

Penyimpangan dalam keluaran sebagai hasil ketidakcekapan teknikal lebih ketara daripada sisihan dalam output akibat komponen *pure noise* dalam output, seperti yang dijelaskan oleh nilai lambda (3.4937). Kesan gabungan faktor ketidakcekapan ladang dapat menjelaskan variasi dalam kecekapan teknikal walaupun beberapa pembolehubah individu tidak signifikan. Faktor input konvensional seperti biji benih, baja, agrokimia dan buruh adalah penting dalam pembangunan pengeluaran kapas ketika ianya meningkatkan purata output secara positif dalam proses pengeluaran. Tingkahlaku pengeluaran yang dicirikan oleh petani kapas di kawasan kajian menujukkan penurunan pulangan ke skala (0.533). Biji benih, baja dan agrokimia adalah mengurangkan risiko pembolehubah input. Oleh itu, pemboleh ubah ini boleh digunakan untuk mengurangkan kesan risiko dalam proses pengeluaran.

Purata kecekapan teknikal yang dikaji menggunakan analisis sempadan stokastik ialah 91.34 peratus. Pengeluar kapas di Negeri Taraba lebih cekap daripada pengeluar kapas di Negeri Adamawa dan Gombe. Pengeluaran kapas yang lebih berpendidikan mempunyai akses kepada kredit tetapi kurang cekap. Faktor lain seperti pengalaman dalam bidang pertanian, hubungan dengan pegawai lanjutan, umur petani dan status perkahwinan mempunyai kesan positif terhadap kecekapan teknikal petani di kawasan kajian. Selain itu, saiz ladang dan aktiviti di luar ladang mengurangkan kecekapan teknikal petani. Pegeluar kapas di kawasan kajian harus digalakkan untuk mempertimbang data demografi seperti akses kepada kredit, pengalaman pertanian, status pendidikan, yang sangat penting kerana ianya membantu dalam meningkatkan kecekapan teknikal, seterusnya tahap hidup mereka. Adalah disyorkan supaya kerajaan mengurangkan kemudahan akses kepada kredit dan memberi penjelasan kepada pengeluar tentang kelebihan untuk meningkatkan mata pencarian mereka. Kesannya, peranan untuk menggunapakai varieti hasil yang tinggi dalam meningkatkan pengeluaran kapas yang tidak hanya mengurangkan tahap ketidakcekapan, risiko pengeluaran dan kecekapan peningkatan di kalangan petani kapas harus diperhalusi bersama.

ACKNOWLEDGEMENTS

All praises are to Allah the ALMIGHTY. The most omniscience benefit and the merciful, who offered the ability and Strength to face and overcome the challenges during the period of my Study to attain the peak level of educational status and indeed accomplish this research work. First and foremost, I must express my gratitude and appreciation to the chairman of supervisory committee Prof Datuk Mad Nasir Shamsudin, his members of the committee, Dr, Ismail Abd Latif and Dr, Alias Radam, for their constructive critics, valuable suggestions, fatherly advices, intellectual and well-articulated guidance throughout the journey of this research study. In fact, I was not only supervised but enthused the desire for academic life.

My appreciation also goes to my lecturer in the Department of Agribusiness, Prof Zainal Abdin Mohammed, Prof Dr, Tai Shzee Yew and Associate Prof Dr, Azman Hassan of Faculty of Economics and Management, for their academic supports and ear listening. My appreciation goes to former Honourable member Jalingo II, Alhaji Aminu Umar Bako, through whom I was employed as Assistant Lecturer in the Taraba State University, Jalingo. Equally, I appreciate my employer, the then vice chancellor of the said University, Prof Mohammed Sani Yahya, and the Sponsor through the Tertiary Education Trust Fund (TETFUND) scheme, Taraba State University, Jalingo.

I would like to acknowledge the prayers and support of my family members, to whom I dedicated this research work to. I must appreciate the support of Global Resource Management, headed by Alhaji Ahmad Jingi and Isa Umar, for their countless financial support rendered throughout the period of my research study. Here, I must be grateful to the Executive director of MUWANSHAT, Alhaji Umar Yola and Alhaji Isiyaku of the Nigerian National Petroleum Corporation, NNPC, Victoria Island Lagos for their kind assistance rendered at all time. Equally worthy of mention are Prof Yakubu Aliyara, Prof A.A.U. Jongur, Dr Surajo Ladan, Dr, Mahmud Umar, Dr, Bakari Usman, Dr, D. C. Maurice, Dr, Auwal Ahmad Mohammed, Dr, Abiso Tijjani, and Dr, Yahya Kaka. My special appreciation goes to my friends, Dr Umar Muktar, Dr Auwal Mohammed and class mate, Dr, Umar Gazali and Dr, Abdul Salam Adamu Jega. Finally, I would like to appreciate the enumerators in the study area, for the job well done in data collection that leads to this successful analysis.

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

Mad Nasir Shamsudin, PhD
Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

Alias Radam, PhD
Associate Professor
Faculty of Economic and Management
Universiti Putra Malaysia
(Member)

Ismail Abd Latif, PhD
Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

_____
ROBIAH BINTI YUNUS, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

Declaration by graduate student

I hereby confirm that:
- this thesis is my original work;
- quotations, illustrations and citations have been duly referenced;
- this thesis has not been submitted previously or concurrently for any other degree at any other institutions;
- intellectual property from the thesis and copyright of thesis are fully-owned by Universiti Putra Malaysia, as according to the Universiti Putra Malaysia (Research) Rules 2012;
- written permission must be obtained from supervisor and the office of Deputy Vice-Chancellor (Research and Innovation) before thesis is published (in the form of written, printed or in electronic form) including books, journals, modules, proceedings, popular writings, seminar papers, manuscripts, posters, reports, lecture notes, learning modules or any other materials as stated in the Universiti Putra Malaysia (Research) Rules 2012;
- there is no plagiarism or data falsification/fabrication in the thesis, and scholarly integrity is upheld as according to the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) and the Universiti Putra Malaysia (Research) Rules 2012. The thesis has undergone plagiarism detection software.

Signature: _____   Date: _____

Name and Matric No.: <u>Muhammad Bala, GS43859</u>

Declaration by Members of Supervisory Committee

This is to confirm that:
- the research conducted and the writing of this thesis was under our supervision;
- supervision responsibilities as stated in the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) are adhered to.

Signature:
Name of Chairman
of Supervisory
Committee: Professor Dr. Mad Nasir Shamsudin

Signature:
Name of Member
of Supervisory
Committee: Associate Professor Dr. Alias Radam

Signature:
Name of Member
of Supervisory
Committee: Associate Professor Dr. Ismail Abd Latif

TABLE OF CONTENTS

xv

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

ACGSF	Agricultural Credit Guarantee Scheme Fund
ADP	Agricultural Development Projects
AE	Allocative Efficiency
ASADP	Adamawa State Agricultural Development Project
ATA	Agricultural Transformation Agenda
ATAP	Agricultural Transformation Action Plan
BOI	Bank of Industry
CBN	Central Bank of Nigeria
CCC	Cotton Consultative Committee
CRFMC	Cotton Revolving Fund Scheme Management Committee
CRS	Constant Return to Scale
CTG	Cotton, Textile and Garment
DEA	Data Envelopment Analysis
DFRRI	Directorate of Food, Road and Rural Infrastructure
DMU	Decision Making Units
DRS	Decreasing Return to Scale
EE	Economic Efficiency
FAOSTAT	Food and Agriculture Organization Statistic
FMARD	Federal Ministry of Agriculture and Rural Development
GDP	Gross Domestic Product
GMT	Greenwich Mean Time
GMT	Greenwich Mean Time
IAR	Institute of Agricultural Research

IFC	International Finance Corporation
IFAD	International Fund for Agricultural Development
IRS	Increasing Return to Scale
MOU	Memorandum of Understanding
MSMEs	Micro, small and medium-sized companies
NACB	Nigerian Agricultural and Co-operative Bank
NALDA	National Agricultural Land Development Authorities
NCMB	Nigerian Commodity Marketing Boards
NE	North East
OLS	Ordinary Least Square
PPF	Possibility Production Frontier
RMDRC	Raw Materials Research and Development Councils
RTS	Return to Scale
RUSEP	Rural Sector Programs
SFA	Stochastic Frontier Approach
SSA	Sub-Saharan Africa
TE	Technical Efficiency
TI	Technical Inefficiency
USDA	United States Department of Agriculture
VRS	Variable Return to Scale
WACOT	West African Cotton Company

CHAPTER 1

INTRODUCTION

1.1   Background of the Study

Agriculture is the backbone or mainstay of many developing countries, as it supplies food for their increasing population, raw materials (cotton, rubber, cocoa) for industries and create employment for teaming population. Agricultural production therefore, can be viewed in terms of crop and livestock production, fisheries, aquaculture and forestry. Spedding (2012) argued that, it is not good enough to merely sorts things, crops, animals, fisheries and aquaculture as major components of the concept of agricultural production, but also to identify the role of science in those components, their agricultural importance and how agricultural production efficiency can be improved and sustained. Therefore, sustainable agriculture which is of paramount importance of meeting society's food and textile needs should be focused on economic efficiency and profitability. Hence, sustained agricultural production cannot be achieved without access to adequate timely production inputs, access to credits by small scale farmers, adequate training on new production technologies and their adoption and high selling price of their final output.

As an engine of most Sub-Saharan Africa (SSA), the International Fund for Agricultural Development (IFAD) report of 2015 shows that Agricultural sector in Nigeria backed 70 percent of the country's employment sector and 30 percent contribution to the Gross Domestic Product (GDP), 40 percent of export earnings with approximately 30 per hundreds of foreign exchange (McNicoll, 2001). Sekumade (2009) pointed out that not long ago, the sector employs about two-thirds of the country's labour force that significantly contributes to the country's GDP, with a large proportion of non-oil earning. Adzawla et al (2013) stress that agriculture in Nigeria is viewed as the sector with largest economoic activities, especially in the rural areas, where almost 50 percent of the population lives. Formerly, Nigeria was an agricultural country as it plays a major role in the survival and growth of its economy. With the discovery of oil in the country, an era that is described as "Oil boom" the agricultural sector is neglected, leading to an impoverishment of the rural population. Although, the country had reached some level of self-sufficiency in staple food production as well as adequate production of raw materials for both domestic industries and exportation abroad in the first decade of political independence, by 1980 onward, the country slides into the position of being the largest food importer of agricultural raw material in Africa. Therefore, there is an urgent need to change the agricultural policies, as it is an engine growth for the economic development. Based on this perspective, scholars like Eyo (2008) suggested that the sector should be a target of government policies over time as it has been the mainstay of the economy, despite several constrains in the sector which remains resilient and sustained the populace. It is on record that in the 1960s, Nigeria was the world's largest exporter of groundnut, the second largest exporter of cocoa and one of the palm oil producing country, as well as the significant exporter of the robber and cotton, Sekumade (2009).

Agricultural sector, therefore, is the fundamental sustenance of life which becomes the basement of economic development that counts a significant share to the country's Gross Domestic Product (GDP) and total export with bulk of the total labour force employment (Awe, 2013).

As pointed out above, Nigeria export of cotton abroad has by far-off remains the most significant natural fibre for it represents 38 percent of the fibre market that is significantly vital for the increase in citizen's income, improve of thier raw materials and as employment provider with adequate in production as well as it processing. Hence, cotton remains one of the additional source of forieng exchange to the government and the one of the largest employer of labour after public sector prior to oil boom, Akpan (2012). Undoubtedly, the agricultural sector played the major roles by the contribution of the crop production sub-sector; in terms of cash crops, mainly cocoa, cotton, groundnuts and some staple food-crops which contributed to the economic expansion of the country, Odedokun *et al* (2015). It is for the focus of this study, therefore, that cotton has been chosen since it plays similar roles in the economy as sub-sector of the crop production.

1.2 Cotton Significance in Nigeria

The cotton and textile sector are significance because they play an important part in the economic development of any nation, as it contributes to its Gross Domestic Product (GDP) as well as creates jobs and income for farmers in that country. In Nigeria, however, there has been a severe decrease in cotton farming, as statistics revealed that the cotton contribution to the country's GDP fell woefully from 25 percent in 1980 to 5 percent as shown by the recent economic indicators. Though in terms of the nominal non-oil contribution to the domestic growth, the agricultural sector has contributed by 5.06 percent which was higher than 4.76 percent recorded in the preceding quarter, which the crop production contributed in the country of 4.23 percent, cotton has to be given prior attention by the government as a result of the set-back experienced in its production in the country (Kriger, 2005).

As one of the majors taking by the government a council called Raw Materials Research and Development Councils (RMDRC) was set whose mandatory are to promote the development and optimal utilization of locally available raw materials by the manufacturing sector of the economy. In addition, the council is also to ensure the development of process equipment or adaptation of existing ones for use by the raw material sector. This is because the sector was one of the major industrial parts which the country had serious pride in as its influence pervaded the whole of Africa and beyond, both in terms of employment generation and contribution to national GDP (National Bureau of Statistics, 2015).

As a result of this large quantity of cotton production and the importance of textile materials, Northern Nigeria textile industry came into being in 1956 (Makinde et al, 2015) and experienced an unprecedented growth in the history of Africa. This made a significant expansion and distribution of textile manufacturers across the West African

countries. The State of Kano in northern Nigeria achieved a high production level of textile materials in the 19th century and became a centre for textile manufacturers in Nigeria as a whole, followed by the Southern Region where the British Cotton Growers' Association opened three large scale ginneries at Abeokuta, Ibadan and Lokoja in Kogi State.

The textile manufacturing in Nigeria spread across the country and had grown to the extent of becoming the third largest in Africa. Because of this development cotton production and textile manufacturing in Nigeria received huge investment from countries such as China and India, bringing about the establishment of over 170 textile manufacturing companies, thereby creating about 600,000 skilled and unskilled employment opportunities. By the year 1980s, the sector generated an annual turnover of $8.95bn and contributed 25% to the country's GDP as previously mentioned. Currently Nigeria's cotton is one of the most important single apparel fibre in the world, having about 1.3 million cotton farmers, with an estimated 17.2 million people who derived their livelihood from the sector.

1.2.1   Cotton Production in Nigeria and It Trend

As the general practice of collecting information, the cotton trend analysis attempt to spot a pattern of cotton production in the country. The trend analysis often used to predict the future occurrence of events and the uncertainty of the past, based on the data at hand. To predict the future trend of cotton as one of the major cash crop in the country, we have to consider the role it played in both economic and social development, which until today, a significant income is being generated as revenue from many agricultural farms in the country. It is on record that cotton and textile activities are boundless in Nigeria whose production dates back before independent (1903). Untill 1974 the British Cotton Growers Association was taking the lead of cotton production in the country but later dissolved and recouped by Cotton Marketing Boaard to develop, gin and market the produce. Following the deregulation of the Nigeria's economy in 1986, the Board was also abolished with the economic activities it rendered. In its place, Cotton Consultative Committee (CCC) was set up to cater the public sector in an advisory capacity, with the Cotton Revolving Fund Scheme Management Committee (CRFSMC) in it place to ensure the sustainable and certified cotton seed supply to the farmers in the country. To address the cotton economy in the integrated manner, the cotton development committee was established in 2005, to incorporate the CCC and CRFMC, Audu (2013). With these development, therefore, cotton production trend in Nigeria may serve as a catalyst to cotton production, though it undergoes a hyperbolic nature as shown in Figure (1.1) below:
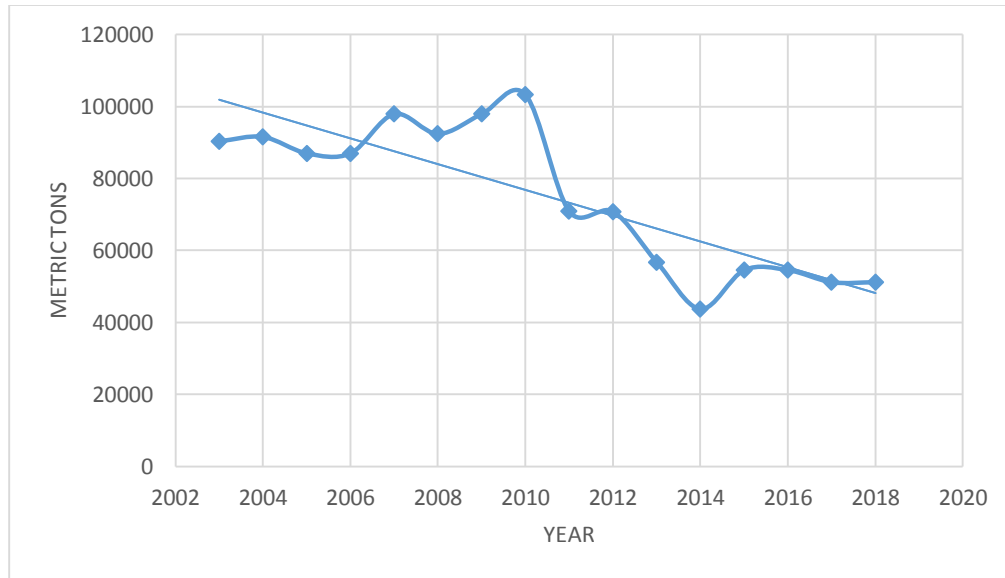
Figure 1.1 : Cotton Production (000 metric tons) in Nigeria, 2003-2018
(Source:USDA, 2018)

The decrease in cotton production from 2009 to 2018, as we can see from the trend line in Figure 1.1, was attributed as a result of the following consequences: Lack of improved seed variaties, low price of the produce, lack of access to credit and the extension services. These were found as the major setback in cotton production for many years as the country is annually losing about $6.5 billion export opportunities in cotton. Right from independent till date, cotton production in Nigeria has been a long term issue, hence it marginal fluctuation that falls inside the dometic demand makes the country's importation from the international market. Nevertheless, there is a colossal prospective for the country to increase production quatity by increasing the area under cultivation and the use of improved seedlings as well as agrochemicals (Hussein, 2008).

1.2.2   Area under Cotton Production in Nigeria, 1979-2018

Record has shown that the area under cotton cultivation on the annual basis, falls within the ranges of 0.2-0.4 million hectares. This can be seen from Figure 1.2 which depict the area under cotton cultivation in Nigeria from 1979 to 2018. The production trend of the area under cultivation, as we can see from this figure was fluctuating, and this may be related to the factors which ranges from the fluke of weather, the fall in cotton price as well as the problems that emanated from the textile industries. Since 1991, in which the country experienced the highest area cultivated, that is, 430,000 hectares of land, the country experienced set-back in the area under cultivation. For instance, between 2012, 2015 and 2018 there was a serious decline in the area under cotton cultivation in Nigeria, most especially in 1995, whereby the production level decreases with more than 50 per cent compared to that of 1991, (USAD, 2018).
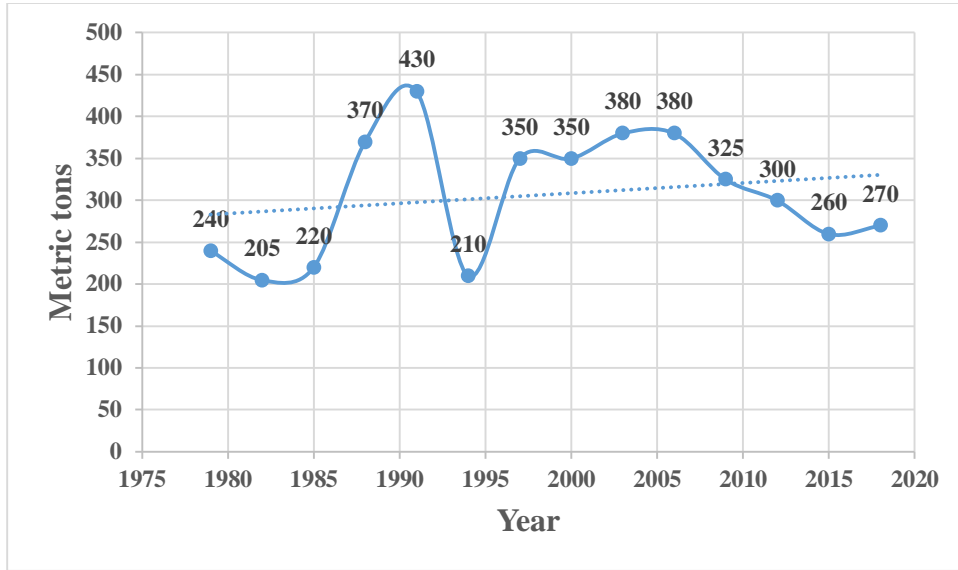
Figure 1.2 : Area under Cotton Production in Nigeria, 1979-2018
(Source: USAD, 2018)

1.2.3   Cotton Producing Areas in Nigeria

In Nigeria, the broad agronomic zones identified cotton producing areas as the Northern and the Southern Zones, with the dispersion into central part of the country. In terms of regions, the following are the major cotton producing areas: Katsina, Zamfara, Kano and Jigawa constituted the cotton producing areas in the Northwest Zone. The places like Adamawa, Taraba, Bauchi, Gombe, Yobe and Borno are the cotton producing areas in the Northeast zone. In the Northcentral Zone, places like Niger and Plateau State are the areas where cotton is being produce. In the Southern Zone, states like Kwara, Ogun, Ondo and Oyo States are the cotton producing areas. However, cotton production is concentrated in the Northern part of the country, especially the Northwest region whereby nearly 80 percent is contributed. The majority of the cotton growers are small and marginal farmers, with their farm sizes ranging from 1-5 hectares under rain fed ecologies. Occasionally, the operations are mechanized and crop harvest is handpicked. As earlier mentioned, there are three (3) main cotton zones in the country, with their respective percentage of their production: with 60 percent from the North, 30 percent from the Easth and 10 percent from the South respectively, Sani (2012). This was presented Figure 1.3 below:

5
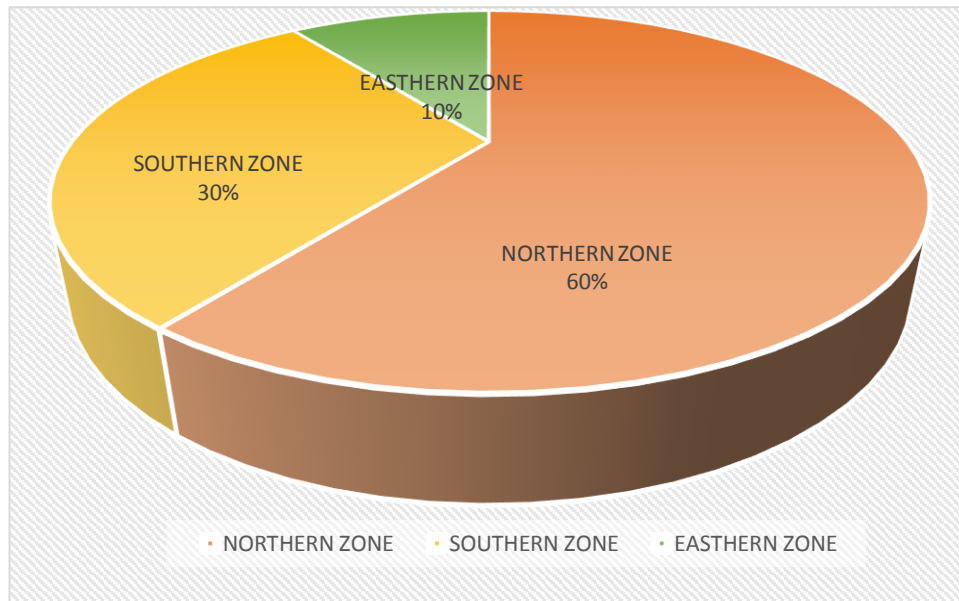
Figure 1.3 : Area under cotton production in Nigeria

1.2.4 Cotton Planted Area, Yield and Cotton Production Trends in Nigeria

Table 1.1 shows the area planted, the yield and cotton production in Nigeria. From the table we can see that apart from 1991 in which Nigeria cultivated the highest number of hectares (430,000) the country experienced down fall in the area under cultivation. This has negative effect on the yield as well as the volume in production. Though the country experienced 10 percent increase in the area cultivated in 2018, that does not make any impact in yield considering the production output, if we compare to that of 2015. In general, from 1979 to 2018 the situation of area under cultivation, the yield and cotton productivity has been in flux in the country. Notwithstanding, there is fluctuation as earlier stated and discussed, some time with an increase in productivity as in 1997, 2000 and 2018. The increase in these years' productivity leads to higher yields of cotton, as their production has shown an increasing trend over time. This may be attributed to the action taken by the Nigerian government, thereby leading to an increase in cotton yield if compared with the area planted in the trend.

Table 1.1 : Area Planted, Yield and Total Production in Nigeria 1979-2018

Year	Area (ha)	Yield (Kg/ha)	Production (Kg)
1979	240	124	29,780
1982	205	96	19,575
1985	220	46	10,005
1988	370	114	41,978
1991	430	140	60,030
1994	210	310	60,683
1997	350	200	70,035
2000	350	249	87,000
2003	380	241	90,263
2006	380	229	87,000
2009	395	248	97,875
2012	300	236	70,688
2015	260	193	50,025
2018	270	190	51,113

(Source: USDA, 2018)
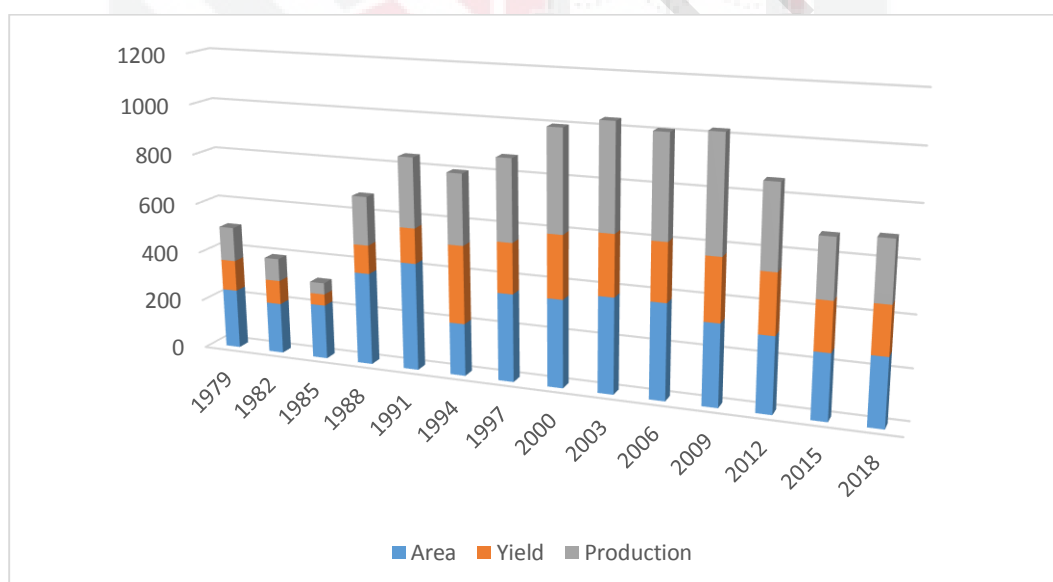
Figure 1.4 : Planted area, average yield and total production in Nigeria
(Source: USDA, 2018)

If we compare the level of cotton production in Nigeria with that of the developed country, USA in this case, where the country leads worldwide in cotton exportation and third ranked in production, we can see that Nigeria has a very long way to go in computing with the developed countries. This can be seen clearly from Table 1.2 below:

Table 1.2 : Area Planted, Yield and Total Production in USA, 1979- 2018

Year	Area (ha)	Yield (Kg/ha)	Production (Kg)
1979	5193	613	3179935
1982	3939	661	3401002
1985	4140	706	2919741
1988	4835	694	3349920
1991	5245	731	3890959
1994	5391	794	4273968
1997	5425	754	4085072
2000	5284	708	3736190
2003	4858	818	3968125
2006	5152	912	4175064
2009	3049	870	2648243
2012	3772	999	3763579
2015	3268	859	2801490
2018	4198	955	4001383

(Source: USDA, 2018)
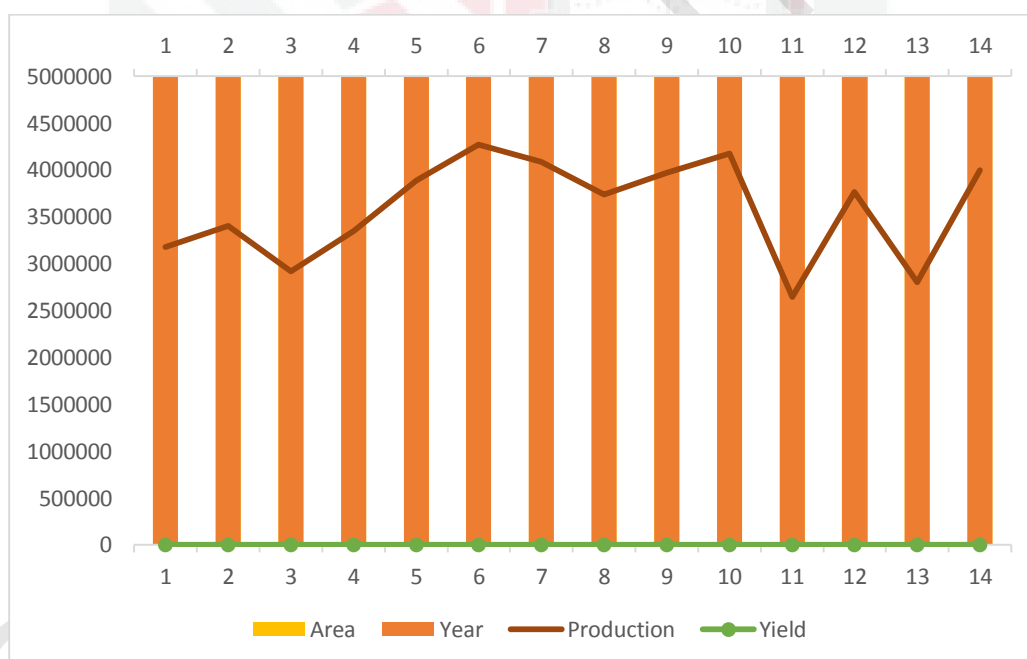
Figure 1.5 : Planted area, average yield and total production in USA
(Source: USDA, 2018)

1.2.5 Imports Quantity of Cotton in Nigeria, 1979-2018

From 1982 through 1988 Nigeria experienced an astronomical importation of cotton into the country to cater for the demand of her domestic industries. Although, from 2006 till date (2018), the volume of cotton importation has been drastically decreasing. Also, in 2009, the quantity has been decreased by 33 percent, while in 2012, 2015 and 2018, the volume of cotton importation into the country has been decreased by 80

8

percent Table (1.3). This may be attributed to the measures taken by the government, of subsidising price of variable inputs and the timely distribution of farm implements to the farmers which in contrast do affect productivity that consequently leading to the importation of cotton into the country (National Bureau of Statistics, 2015).

Table 1.3 : Imports Quantity/Imports Value of Cotton in Nigeria, 1979-2018

Year	Imports Quantity(Mt)
1979	14
1982	115
1985	184
1988	207
1991	93
1994	115
1997	69
2000	70
2003	70
2006	75
2009	50
2012	10
2015	10
2018	10

(Source: USDA, 2018)
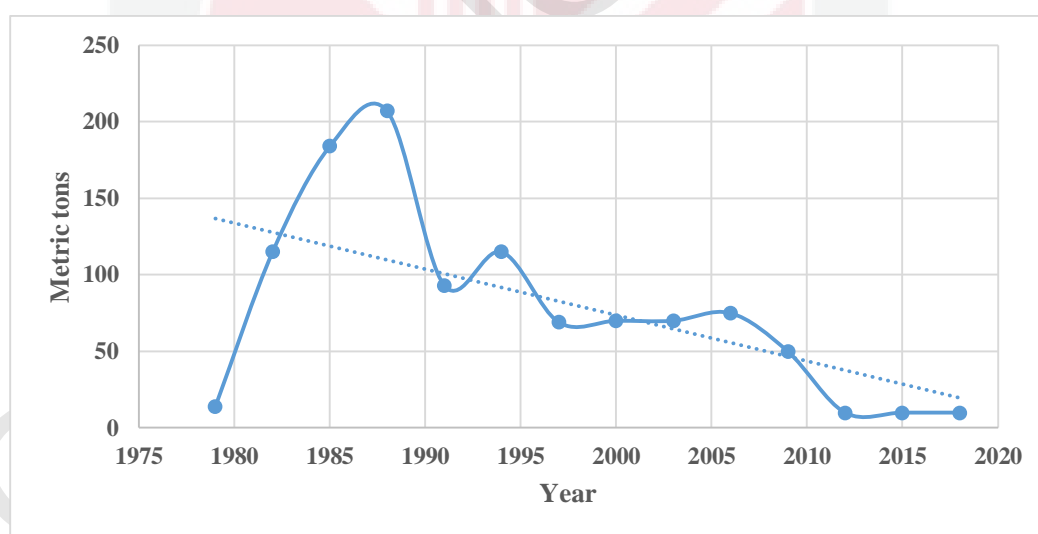
Figure 1.6 : Imports Quantity of cotton in Nigeria, 1979-2018
(Source: USDA, 2018)

1.2.6   Exports Quantity of Cotton in Nigeria, 1979-2018

For the complete two decades of cotton exports, that is 1979-2018, with the exception of 1988 where 32 metric tons were exported, Nigeria experienced a serious setback in terms of her cotton exportation, to the extent that zero value was recorded (Table 1.4).

This shows that throughout these period the country has not been exporting cotton but importing from abroad. In 2000, Nigeria exports 135 metric tons of cotton from abroad into the country. Equally in 2012, the country experienced the highest quantity of export whereby compared to that of 2009 there was 11% increase of cotton export into the country. Since then, the volume of cotton export by Nigeria was drastically reduced by 86%. This may be allied to decrease in the volume of productivity by small-scale farmers in the country, instability in the macroeconomic environment, new export policy which favoured few selected citizens, the impact of the new package on the resource allocation and the efficiency protection on industries. Jamali and Anka (2011) recommended that priority should be given to a quantum increase in export as part of economic planning of the country. This is because there are significant impacts on the country's revenues and the balance of current account, in the long run as well as in the short run. Although, there is an increased level of the country's export of goods and services that plays important role in the development plan of Nigeria in her foreign exchange, the scarcity of some goods and their services constitutes a critical bottleneck. Hence, the country's export can largely meet her foreign exchange gap, vi-ser-vi the export growth, for the betterment of the economy, by increasing the import capacity of the country that would boost up the industrialization and the economic activities as well (National Bureau of Statistics, 2015).

Table 1.4 : Exports Quantity of Cotton in Nigeria, 1979-2018

Year	Exports Quantity(Mt)
1979	0
1982	0
1985	0
1988	32
1991	0
1994	0
1997	0
2000	135
2003	90
2006	125
2009	225
2012	250
2015	35
2018	30

(Source: USDA, 2018)

This can be explained in Figure 1.7, where the dot shows the level of cotton exportation abroad especially in the 2012.
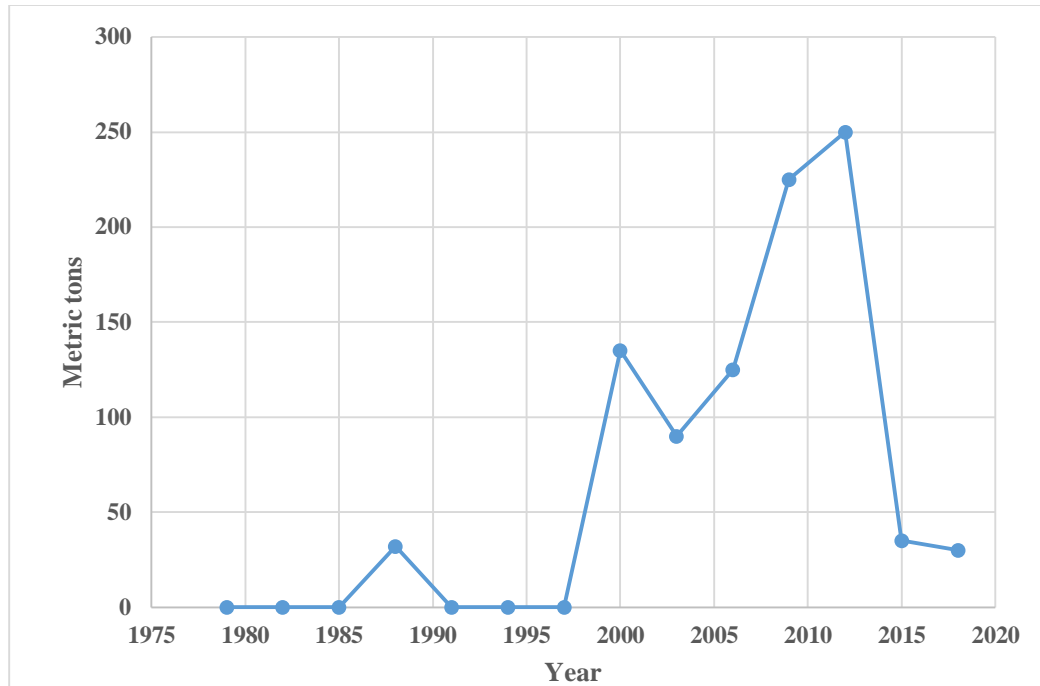
Figure 1.7 : Exports Quantity of cotton, 1979-2018
(Source: USDA, 2018)

1.2.7   Cotton Consumption and Production Trend in Nigeria, 1979-2018

The consumption of cotton in Nigeria has been increasing due to the expansion of the cotton industries in the country. Table 1.5 indicated that the total cotton consumption in the country from 1979 to 2018 exceeded the production value by over 8%. Though the value of the cotton consumes in the country from 2006 to 2015 has minimally reduced by over 12% in 2009, 16% in 2012 and 11% in 2015, it has increased to over 11% in 2018. This shows that the government's attention has been drawn to cotton production as a result of the increase in its consumption in the country. In other words, the country experienced a marginal decline in its domestic cotton consumption that consequently forced it to imports cotton from abroad to cater for her domestic consumption. This can be see vividly from the data recorded in Table 1.5.

11

Table 1.5 : Cotton Consumption and Production trend in Nigeria, 1979-2018

Year	Consumption (kg)	Production (kg)
1979	45,458	29,780
1982	44,153	19,575
1985	55,028	10,005
1988	77,865	41,978
1991	67,860	60,030
1994	87,000	60,683
1997	82,868	70,035
2000	81,563	87,000
2003	89,175	90,263
2006	78,300	87,000
2009	65,250	97,875
2012	43,500	70,688
2015	38,063	50,025
2018	43,500	51,113
Total	**899583**	**826050**

(Source: USDA, 2018)

The consumption trend follows the production movement because it vividly shows the excess of the country's demand of cotton with the quantity its produces. For instance, from 1979 through 1997, Nigeria has to import cotton to cater for the demand of her textile companies, as what she consumes exceeded the quantity she produces. Although, from the year 2000 to 2018 the level of cotton production superceed the consumption level, the country has to emback on cotton importation as there is 8.17% gap between its consumption and the production level.
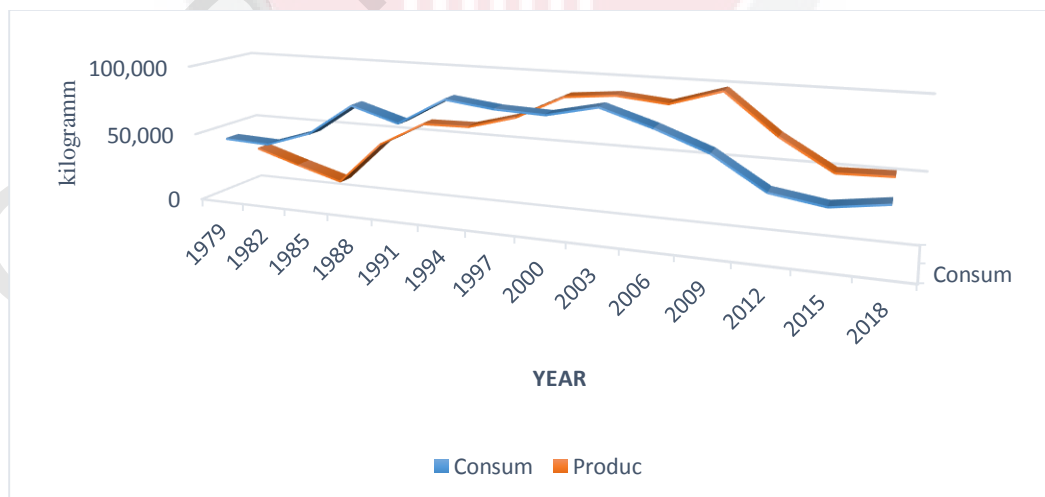
Figure 1.8 : Cotton Consumption and Production trend in Nigeria, 1979-2018
(Source: USDA, 2018)

As the total cotton supply in Nigeria is a function of domestic production and cotton import, the domestic production of cotton on the other hand, is determined by several variables including the area planted and harvested, climate conditions, farm management practices and government policies. For more larification, the data on Table 1.6 shows that domestic cotton supply in Nigeria has increased from 36,323 metric tons in 1980 to 39,585 metric tons in 2018 as a result of increased production and importion of cotton into the country. For instance, in 2018, domestic production represented about 78.6% of total supply while import accounted for around 10%. Though importation has increase with more than 2% this has been taken care up with 10% increase in production in the year 2018.

Table 1.6 : Cotton Production, Import and Stocks in Nigeria, 1980-2018

Year	1980	1990	2000	2010	2018
Production (000 mt)	27188	35888	87000	103313	51113
Import (000 mt)	0.00	0.00	29363	48938	6525
Beginning Stocks (000 mt)	9135	6743	31320	30233	11745
Domestic Supply (000 mt)	36323	88523	133545	144420	65033
Production as % of Domestic Supply	74.85	40.54	65.15	71.54	78.60
Imports as % of Domestic Supply	0.00	0.00	11.40	7.53	10.03

(Source: USDA, 2018)

But the domestic cotton demand in the country is mostly for cotton seed which could rise from 1.0 million tons to 1.5 million tons depending on the textile industries revitalisation. Nevertheless, the domestic consumption is a mixed picture that is highly popular in the country, the designers and manufactures of cotton have moved their focus on not only using cotton for clothing, but for creating beautiful remanufacturing, leading to the Bespoke virgin cotton garments that exist in the market and reserved for the luxury. For the consumption of the next generation, therefore, the cotton garments are hereby cherished and handed down to them, as its demand attracted people's investment in clothing and textile design. In line with this development, the Federal Ministry of Agriculture and Rural Development report of 2016 shows that the outcome of this attraction has taken some to selling of second-hand clothing to boost their income, as its demand is higher resulting to the emergence of consumers of second-hand luxury market with limited spending power as well as limited fabric supply, as the country demand 0.7 million but supply only 0.2 million (McNicoll, 2001).

Nigeria is an agricultural country and the 14th largest in Africa, with the total land area of 92.3768 million hectares, where 77.736 million hectares have been used for agricultural purposes. Returning to cotton, it is one of the major produce whose area under cultivation decreases by 1.85%. in the year 2017 and 2018, as shown in Table 1.7. Besides cotton, which is a major cash crop, there are several other crops planted such as Sorghum, Palm oil, Corn, Millet, and Rice. As the twenty-seventh World's Cotton Production and the fourth exporting country, Nigeria has keen concern over the decreased in the planted area. On the contrary, planted area for Sorghum has also experienced a decrease of (-0.28). Though Rice has been increase by 6.81 percent,

other crops like Corn, Millet and Palm oil maintained their area under cultivation respectively.

Table 1.7 : Main Agricultural Products in Nigeria, 2016-2018

<div align="right">Unit: 1000 Hectares</div>

Types of plant	Years			Percentage change (%)
	2016	**2017**	**2018**	
Cotton	275	270	270	-1.85
Sorghum	5816	5800	5800	-0.28
Corn	6500	6500	6500	0.00
Millet	1736	1500	1500	0.00
Rice	2996	3200	3200	6.81
Palm oil	2500	2500	2500	0.00
Total	**19823**	**19770**	**19770**	**4.68**

(Source: USDA, 2018)

These other crops and energy plant have been the new cash crops for farmers due to their prices and government support. Palm oil is used to produce ethanol when mixed with gasoline. Some agricultural products, like Sorghum and Millet, are under the threat of price fluctuations. The government has to provide support to their farmers by receiving the price control schemes.

1.3   Statement of the Problem

In Nigeria, cotton farming is naturally operated with risk that mostly emanated from these, namely weeds, pests, diseases, inadequate supply of the quantity of seed, lack of the giving backing of the extension staff by the government to enlighten the farmers on how to adapt the modern farming system and intensive management practices. In addition to the said problems, other constrains includes low yield which emanated from low-quality seeds, high cost of production and lack of strict adherence to good agronomic practices by the farmers, unable to have access to credit and their inability to farm efficiently, as identified by previous studies Ogunlela, (2004). Despite the importance of cotton in the nation's economy, the actual cotton yield in the country was low as its fall within the range of 0.4-0.5 t/ha, compared to the genetic-yield range of 2.5-3.0 t/ha in the country as asserted by Ogunlela, (2004). The varieties grown and the yield attainable, according to research, is between 1.5-2.5 t/ha as there are continuous decline and fluctuation in farmers' productivity due to increasing rate of diseases, pests and soil fertility. This caused the uncertainties in every cropping season of production in which there is need to examine the effect of inputs on the output variance through the choices of model of production risk in inputs variation. With the realization of output that is uncertain, the ability of farmers to obtain maximum yield given the set of input factors is influenced by their input's decision as well as environmental factors. Though some input factors may contribute positively to the realization of output while others may not, factors that are related to environments

14

such as the incidence of pests and diseases, drought and floods are ultimately affect the ability of farmers to obtain high yields.

Farmers' goal is to obtain the maximum yield by employing input factors. It's unfortunate that variations between observed and maximum achievable yield are undesirable. Therefore, farmers' input choices tend to affect the extent of observed output variability. Hence, the employment of certain input factors in the production process may result in the observance of high fluctuation in yield or otherwise. For input allocation decision, the nature of input factors with regards to how they affect output variable (risk) is therefore necessary. It's a known fact that variability of output with respect to input use is the risk associated with the production process. Consequently, it is a very vital fact to assess the performance of cotton farmers in the study area so that the gravity of risk will be considered into account, as it might be a factor when choosing between production plans. Certain socioeconomic and managerial factors that may boost production should also be identified. For instance, lack of accounting for production risk with respect to input use may result to biasness in the estimation of technical efficiency and may be misleading to policy makers.

Though, efforts were made by the Federal Government of releasing N54 billions for the improvement of cotton production in the country, in September 2012 and signing of the Memorandum of Understanding, (MoU) with the West African Cotton Company (WACOT) still on her plans to revive cotton production in the country as a demonstration to its commitment to cultivating cotton in the country.

In the actual sense the aim of this agreement with WACOT, of enhancing the productivity of the ginneries from 150kg to 450kg of cotton lint was not realised as the present production of cotton seeds is fluctuating in every cropping season despite the awareness and training of farmers on modern agronomic practices that will restore Nigeria's fortune in the area of cotton production by the West Africa Cotton (WACOT) in fulfilling the signed agreement. This was testified by the Project Leader Dr. Laxman Dhayal, that the training, as scheduled, was started in Gombe State with about 900 cotton farmers, targeting 15, 000 hectares of land to be cultivated but apprehended over 13,000 hectares at last. With the highlight by project leader, the programme is important in this scientific world for the betterment of cotton farmers to improve on the quality and production capacity of cotton in Nigeria. Nevertheless, the programmes will also bring back the glory of cotton farming and production in Nigeria, adding that the future looks bright for improvement of cotton in the country.

Unfortunately, despite these above-mentioned programmes and their importance in reviving the cotton sector by the Federal Government, there are precipitous fall in the required yield as a result of the un-intensive use of inputs and inefficient management of cotton farms. Thus, an improvement in the efficiency of input used and that of farm inputs will be fundamental, and its measurement in the existing farm including risk properties of inputs are therefore much more useful. Though there are several studies on efficiency aspect of cotton production conducted and applied stochastic production frontier in measuring technical efficiency by different researchers, yet, the production

risk of inputs that provide the information on whether input(s) is risk decreasing or risk increasing did not receive the special attention on those studies. In view of this development, therefore, this study will model the production risk and technical efficiency of cotton production as their effects on inputs use affect output variance, with the view of supporting the policies improving farmers' efficiency that will increase their productivity of cotton farms while meeting the efficient utilization of their resources to achieve self-sufficiency level.

1.4   Research Questions

The following research questions were formulated based on the objectives of the study:

1)   What are the production risk behaviour of cotton farmers with respect to their inputs?
2)   Do the farmers' attitude towards risk affect their technical efficiency?
3)   Which of models that influenced farmers' technical efficiency?
4)   What are the factors that affect farmers'technical efficiency?

1.5   Objectives of the Study

The general objective of the study is to determine the production risk and technical efficiency of cotton production in the North-Eastern Zone of Nigeria. The specific objectives of the Study are to:

1)   Determine the production risk behaviour with respect to farmer's inputs;
2)   Determine the technical efficiency with respect to farmer's attitudes towards risk;
3)   Compare the farmer's technical efficiency using DEA and SFA; and
4)   Determine the factors affecting the technical efficiency of the farmers.

1.6   Significance of the Study

From the viewpoint of the theory of the firm, the most important consideration is the impact of making decisions in a risky environment that resulted from uncertainty (weather, pests, diseases,) production, market and price (input and output), and financial (interest rates) on their decision making. Though farmers manage risk by their attitudes towards it, strong evidence showed that they are universally risk averse, that is avoiding risk through various institutional and management mechanisms.

For good policy implementation on the right input mix to increase output, estimate of input factors to cotton output will provide insight on the various technological input/output relationship and the extent to which output will change if input factors changed. This will be assured by estimated scale of elasticity of production, as it gives an indication of the change in output when all the factors of inputs varied by the same proportion. For input allocation decision, findings from production risk component will give insight into how the individual technological inputs affects variation in output. Therefore, information on these are necessary since some technological input factors may tend to increase output variance or otherwise.

The technical efficiency indices, as computed, will reveal the extent of technical and allocative inefficiencies whose levels give an indication of how efficient the farmers are in terms of their production process and the potential for its improvement. The uncertainty associated with input use in production process should be accounting for technical efficiency.

In addition, the relevant factors that can improve technical efficiency in cotton production process in the study area will be identified. Knowledge on these will provide useful information for the stakeholders that are involved in the design and implementation of programs and policies, aimed at improving cotton production, particularly in the study area and Nigeria at large. It is therefore important to improve technical efficiency of cotton production as it will evidently result in increased output that will go a long way of improving the income of the farmers and their standard of living. The outcome of this study will also be useful to the farmers in the study area as it will exert their effort to cope with the barriers which resulted from the determinants found during their production process, in order to optimize their outputs while minimizing production cost, and to mitigate the risk involvement in their production process.

1.7   Organization of the Thesis

This thesis is organized into five (5) chapters. Chapter one deals with the background of the study, Cotton significance in Nigeria that comprises its production and its current situation, risk in agricultural production, policy environment, statement of the problem, objectives and significance of the study. Chapter two (2) presents the literature review of the various approaches for efficiency measurements that includes parametric and non-parametric (deterministic and stochastic frontier approaches), production risk and the incorporation of production risk in the stochastic frontier model as well as the empirical applications of the various approaches. Chapter three (3) outlines the methodology employed for the study that comprises information about the method of the analysis, viz: theoretical framework, empirical analysis for estimating technical efficiency and production risk and the hypothesis test and conceptual framework. In addition, it outlines the data and sampling technique employed with information about the study area. Chapter four (4) presents the results and discussion of the study area with respect to each specific objective, summary statistic of the output and input variables, description of socio-economic characteristic

of the respondents, results of the various hypotheses tested, the estimation of the marginal output risk level and the inefficiency model estimation of the profit function model. Lastly, chapter five (5) presents the summary, policy implications and conclusion of the whole study.

REFERENCES

Abatania, L. N., Hailu, A., & Mugera, A. W. (2012, February). Analysis of farm household technical efficiency in Northern Ghana using bootstrap DEA. In *56th annual conference of the Australian Agricultural and Resource Economics Society*.

Abedullah, S. K. And K. M. (2007). Analysis of technical efficiency of rice production in Punjab, Pakistan. *Pakistan Economic and Social Review, 45(2), 231–244.*

Abiayi, E. A., Inabo, H. I., Jatau, E. D., Makinde, A. A., Sar, T. T., Ugbe, D. A. & Okewole, P. A. (2015). Knowledge, attitudes, risk factors and practices (KARP) that favor Leptospira infection among abattoir workers in North Central Nigeria. *Asian Journal of Epidemiology*, *8*(4), 104-13.

Adesina, A. A., & Djato, K. K. (1996). Farm size, relative efficiency and agrarian policy in Côte d'Ivoire: Profit function analysis of rice farms. *Agricultural Economics*, *14*(2), 93-102.

Adinku, E. O. (2013). Production Risk and Technical Efficiency of Irrigated Rice Farms in the Greater Accra and Volta Regions of Ghana, (Unpublished Doctoral dissertation, University of Ghana, Ghana).

Adzawla, W. Fuseini, J. and Donkoh, S. (2013). Estimating Technical Efficiency of Cotton Production in Yendi Municipality, Northern Ghana. *Journal of Agriculture and Sustainability, 4*(1), 115–140.

Ahmadu, J. & Alufohai, G. O. (2012). Estimation of Technical Efficiency of Irrigated Rice Farmers in Niger State. *American-Eurasian Journal of Agriculture & Environmental Sciences, 12(12), 1610-1616.*

Aigner, D., Lovell, C. K., & Schmidt, P. (1977). Formulation and estimation of stochastic frontier production function models. *Journal of econometrics*, *6*(1), 21-37.

Aigner, D.J. and Chu, S. F. (1968). Estimating the Industry Production Function *American Economic Review*, *58*, 826–839.

Akpan, N. S. (2012). From Agriculture to Petroleum Oil Production : What Has Changed about Nigeria's Rural Development. *International Journal of Developing Societies*, *1*(3), 97–106.

Alain, C. (2015). *African Farming and Food Processing*, Africanfarming.net

Alam, M. K., Aboki, E., Gidado, E. H., & Buba, D. D. (2013). Economic Analysis of Cotton Production in Selected Local Government Areas of Taraba State, Nigeria. *Journal of Agricultural Sciences*, *4*(1), 27-31.

Alemdar, T., & Ören, M. N. (2006). Measuring technical efficiency of wheat production in southeastern Anatolia with parametric and nonparametric methods. *Pakistan Journal of Biological Sciences*, *9*(6), 1088-1094.

Alene, A. D., & Hassan, R. M. (2008). Efficiency of food production under old and new technology: The case of farmers within and outside the Extension Package Program in Ethiopia. *The Journal of Developing Areas*, 233-249.

Al-Hassan, S. (2008). Technical efficiency of rice farmers in Northern Ghana. *African Journal of Agricultural Research* 7(14), 2131-2141.

Ali, F., Parikh, A., & Shah, M. K. (1996). Measurement of economic efficiency using the behavioural and stochastic cost frontier approach. *Journal of Policy Modelling*, *18*(3), 271-287.

Amaza, P. S., & Maurice, D. C. (2005). Identification of factors that influence technical efficiency in rice-based production systems in Nigeria. *Rice Policy and Food Security in sub-Saharan Africa*, *70*.

Amaza, P. S., Udoh, E. J., Abdoulaye, T., & Kamara, A. Y. (2010). Analysis of technical efficiency among community-based seed producers in the savannas of Borno State, Nigeria. *Journal of Food, Agriculture & Environment*, *8*(2 part 2), 1073-1079.

Amor, T. B., & Muller, C. (2010). Application of stochastic production frontier in the estimation of technical efficiency of Irrigated Agriculture in Tunisia. *Agricultural Journal*, *5*(2), 50-56.

Antle, J. (1983). Testing the Stochastic Structure of Production: A Flexible moment-based approach. *Journal of Business & Economic Statistics*, *1*(3), 192–201.

Asche, F., & Tveterås, R. (1999). Modeling production risk with a two-step procedure. *Journal of Agricultural and Resource Economics*, 24(4), 424-439.

Audu, J. (2013). Reviving Nigeria Ailing Textile Industry. *Leadership News Paper*. https://doi.org/10.1017/CBO9781107415324.004

Awe, A. A. (2013). Mobilization of domestic financial resources for agriculturalproductivity in Nigeria. *Australian Journal of Business and Management Research*, 2(12), 1-7.

Bäckman, S., Islam, K. Z., & Sumelius, J. (2011). Determinants of technical efficiency of rice farms in North-Central and North-Western regions in Bangladesh. *The Journal of Developing Areas*, 7(12), 73-94.

Banker, R. D., Charnes, A., & Cooper, W. W. (1984). Some models for estimatingtechnical and scale inefficiencies in data envelopment analysis. *Management Science*, *30*(9), 1078-1092.

Bakhsh, K. (2007). An analysis of technical efficiency and profitability of growing potato, carrot, radish and bitter gourd: A case study of Pakistani Punjab. (*Unpublished PhD Dissertation, University of Agriculture, Faisalabad, Pakistan)*.

Battese, G. E., & Broca, S. S. (1997). Functional forms of stochastic frontier production functions and models for technical inefficiency effects: a comparative study for wheat farmers in Pakistan. *Journal of productivity analysis*, *8*(4), 395-414.

Battese, G.E, and Coelli, T. J. (1988). Prediction of firm-level technical efficiencies with a generalized frontier production function and panel data. *Journal of Econometrics*, *38*, (3), 387–399.

Battese, G.E, and Coelli, T. J. (1995). A Model for technical inefficiency effects in a stochastic frontier production function for panel data. *Empirical Economics, 20(2), 325-332*.

Battese, G. E., Coelli, T. J., & Colby, T. C. (1989). *Estimation of frontier production level functions and the efficiencies of Indian farms using panel data from ICRISAT's village studies* (pp. 327-348). Department of Econometrics, University of New England.

Battese, G. E., & Coelli, T. J. (1992). Frontier production functions, technical efficiency and panel data: with application to paddy farmers in India. *Journal of productivity analysis*, *3*(1), 153–169.

Battese, G. E., & Corra, G. S. (1977). Estimation of a production function model with application to the pastoral zone of Eastern Australia. *Australian Journal of Agricultural Economics*, *21*(3), 169–179.

Binswanger, H. P. (1981). Attitudes Toward Risk: Theoretical implications of an experiment in rural India. *The Economic Journal*, *91*(364), 867–890.

Bokusheva, R., & Hockmann, H. (2006). Production risk and technical inefficiency in Russian agriculture. *European Review of Agricultural Economics*, *33*(1), 93–118.

Bozoğlu, M., & Ceyhan, V. (2007). Measuring the technical efficiency and exploring the inefficiency determinants of vegetable farms in Samsun province, Turkey. *Agricultural systems*, *94*(3), 649-656.

Bravo-Ultra, B.E & Riegger, L. (1991). Dairy farm efficieency measurement using stochastic frontier and neo-classical duality. *American Journal of Agricultural Economics*, *73*(2), 421–428.

Bravo-Ureta, B. E., & Pinheiro, A. E. (1993). Efficiency analysis of developing country agriculture: a review of the frontier function literature. *Agricultural and resource economics Review*, *22*(1), 88-101.

Bravo- Ureta, B. E., & Pinheiro, A. E. (1997). Technical, economic, and allocative efficiency in peasant farming: evidence from the Dominican Republic. *The Developing Economies*, *35*(1), 48-67.

Bulama, A.T. (2016). Technical Efficiency and Risks Associated with Production Inputs Among Oil Palm Smallholders According to Crop Image in Peninsular, Malaysia. *(Unpublished PhD thesis, University Putra Malaysia)*

Burki, A. A., & Terrell, D. (1998). Measuring production efficiency of small firms in Pakistan. *World Development*, *26*(1), 155-169.

Chakraborty, K., Misa, S., & Johnson, P. (2002). Cotton Farmers' Technical Efficiency: Stochastic and non-stochastic production function approaches. *Agricultural and resource economic, 31*(2), 211-220.

Charnes, A., Cooper, W. W., & Rhodes, E. (1978). Measuring the efficiency of decision making units. *European journal of operational research*, *2*(6), 429-444.

Chepng'etich, E., Bett, E. K., Nyamwaro, S. O., & Kizito, K. (2014). Analysis of technical efficiency of sorghum production in lower eastern Kenya: a data envelopment analysis (DEA) approach.

Chimai, B. C. (2011). *Determinants of technical efficiency in smallholder Sorghum farming in Zambia* (Doctoral dissertation, The Ohio State University).

Cobanoglu, F. (2013). Measuring the technical efficiency of cotton farms in Turkey using stochastic frontier and data envelopment analysis. *Outlook on Agriculture*, *42*(2), 125-131.

Coelli, T. J., & Battese, G. E. (1996). Identification of factors which influence the technical inefficiency of Indian farmers. *Australian Journal of Agricultural Economics*, *40*(2), 103-128.

Coelli, T. J., Rao, D.S.P., O'Donnell, C. J., & Battese, G. E. (2005). *An introduction to efficiency and productivity analysis.* Spring Science & Business *Media,* Springer, Boston, MA.

Coelli, T. (1998). A multi-stage methodology for the solution of orientated DEA models. *Operations Research Letters*, *23*(3), 143–149.

Cullinane, K., Wang, T. F., Song, D. W., & Ji, P. (2006). The technical efficiency of container ports: comparing data envelopment analysis and stochastic frontier analysis. *Transportation Research Part A: Policy and Practice*, *40*(4), 354-374.

Dantsis, T., Douma, C., Giourga, C., Loumou, A., & Polychronaki, E. A. (2010). A methodological approach to assess and compare the sustainability level of agricultural plant production systems. *Ecological Indicators*, *10*(2), 256–263.

Debreu, G. (1951). The Coefficient of Resource Utilization. *Econometrica*, *19*(3), 273-292. https://doi.org/10.2307/1906814

Donkoh, S. A., Ayambila, S., & Abdulai, S. (2013). Technical efficiency of rice production at the Tono irrigation scheme in northern Ghana *African Journal of Agricultural and Resource Economics*, *9*(4), 286-299.

Ekoja, I. I. (2003). Farmers' access to agricultural information in Nigeria. *Bulletin of the American society for information science and technology*, *29*(6), 21-23.

Eyo, E. O. (2008). Macroeconomic environment and agricultural sector growth in Nigeria. *World Journal of Agricultural Sciences*, *4*(6), 781–786.

Evenson, R. E. (1994). Efficiency in agricultural production. *Journal of Agricultural economics*, *10(3)*, 27-37.

FAOSTAT. (2016). Food and Agricultural Organisation of the United Nations. Retrieved from http://faostat.fao.org/

Färe, R., Grosskopf, S., & Lovell, C. K. (2013). *The measurement of efficiency of production* (Vol. 6). Springer Science & Business Media.

Farrell, M. J. (1957). The Measurement of Productive Efficiency. *Journal of the Royal Statistical Society. Series A*, *120*(3), 253–290.

Fasasi, A. R. (2007). Technical efficiency in food crop production in Oyo state, Nigeria. *Journal of Human Ecology*, *22*(3), 245-249.

Featherstone, A. M., Langemeier, M. R., & Ismet, M. (1997). A nonparametric analysis of efficiency for a sample of Kansas beef cow farms. *Journal of Agricultural and Applied Economics*, *29*(1), 175-184.

Fouché, C. B., & Delport, C. S. L. (2005). Introduction to the research process. *De Vos, AS, Strydom, H., Fouché, CB & Delport, CSL*, 71-85.

Fufa, B., & Hassan, R. M. (2003). Stochastic maize production technology and production risk analysis in Dadar district, East Ethiopia. *Agrekon*, *42*(2), 116-128.

Gadbo, B. H. (2014). *Efficiency of Livestock-oil Palm Integration Under Small Holder Scheme in Johor, Malaysia* (Unpublished Doctoral dissertation, Universiti Putra Malaysia).

García del Hoyo, J. J., Castilla Espino, D., & Jiménez Toribio, R. (2004). Determination of technical efficiency of fisheries by stochastic frontier models: a case on the Gulf of Cadiz (Spain). *ICES Journal of Marine Science*, *61*(3), 416-421.

Ghee-Thean, L., Latif, I. A., & Hussein, M. A. (2012). Application of Stochastic Frontier and Data Envelopment Analyses on Trawl Fishery. *Journal of Applied Sciences*, *12*(1), 48-55.

Ghorbani, A., Amirteimoori, A., & Dehghanzadeh, H. (2010). A comparison of DEA, DFA and SFA methods using data from Caspian Cattle Feedlot Farms. *Journal of Applied Sciences*, *10*(14), 1455-1460.

Gopalakrishnan, C., Wickramasinghe, W. A. R., Gunatilake, H. M., & Illukpitiya, P. (2005). Estimating the demand for non-timber forest products among rural communities: a case study from the Sinharaja Rain Forest region, Sri Lanka. *Agroforestry Systems*, *65*(1), 13-22.

Gorton, M., & Davidova, S. (2004). Farm productivity and efficiency in the CEE applicant countries: a synthesis of results. Journal of *Agricultural economics*, *30*(1), 1-16.

Green, P. J., & Silverman, B. W. (1993). *Nonparametric regression and generalized linear models: a roughness penalty approach*. CRC Press.

Gul, M., Koc, B., Dagistan, E., Akpinar, M. G., & Parlakay, O. (2009). Determination of technical efficiency in cotton growing farms in Turkey: A case study of Cukurova region. *African Journal of Agricultural Research*, *4*(10), 944–949.

Idiong, I. C. (2007). Estimation of farm level technical efficiency in smallscale swamp rice production in cross river state of Nigeria: a stochastic frontier approach. *World Journal of Agricultural Sciences*, *3*(5), 653-658.

Iliyasu, A., & Mohamed, Z. A. (2016). Evaluating contextual factors affecting the technical efficiency of freshwater pond culture systems in Peninsular Malaysia: A two-stage DEA approach. *Aquaculture Reports*, *3*, 12-17.

Ismail, E. A. (2015). A Tobit Regression Approach Based on DEA Efficiency Scores. *Global Journal of Engineering Science and Research Management*, *2*(4),1-7

Harold O. Fried, Lovell, C. K., & Shelton S. Schmidt. (1993). *The measurement of productive efficiency: techniques and applications*. Oxford University Press.

Haji, J. (2007). Production Efficiency of Smallholders' Vegetable-dominated Mixed Farming System in Eastern Ethiopia: A Non-Parametric Approach. *Journal of African Economies*, *16*(1), 1–27.

Hazell, P. B. R. (1982). Application of Risk Preference Estimates in Firm-Household and Agricultural Sector Models. *American Journal of Agricultural Economics*, *64*(2), 384–390.

Heshmati, A. (1994). "Estimating Technical Efficiency, Productivity Growth and Selectivity Bias Using Rotating Panel Data: An Application to Swedish Agriculture." Ph.D. Thesis, Department of Economics, University of Giiteborg ksagaton 1, S-411 80 Gijteborg, Sweden.

Helvoigt, T. L., & Adams, D. M. (2009). A stochastic frontier analysis of technical progress, efficiency change and productivity growth in the Pacific Northwest sawmill industry. *Forest policy and economics*, *11*(4), 280-287.

Huffman, W. E. (1980). Farm and off-farm work decisions: The role of human capital. *The Review of Economics and Statistics*, 14-23.

Hussein, K. (2008). Cotton in West and Central Africa: Role in the regional economy & livelihoods and potential to add value. In *Proceedings of the Symposium on Natural Fibres (FAO, Rome)*.

Jamali, S., & Anka, D. L. (2011). Trade Policy in Developing Countries: A Case Study of Nigeria and Pakistan. *Asian Social Science*, *8*(12), 171.

Javed, M. I. (2009). Efficiency analysis of cotton-wheat and rice-wheat systems in Punjab, Pakistan. *Unpublished Doctoral Thesis, University of Agriculture, Faisalabad*.

Jondrow, J., Lovell, C. K., Materov, I. S., & Schmidt, P. (1982). On the estimation of technical inefficiency in the stochastic frontier production function model. *Journal of Econometrics*, *19*(2), 233–238.

Just, R. E., and Pope, R. D. (1978). Stochastic specification of production functions and economic implications. *Journal of Econometrics*, *7*(1), 67–86.

Just, R. E., & Pope, R. D. (1979). Production function estimation and related risk considerations. *American Journal of Agricultual Economics*, *61*(2), 276–284.

Kammoun, R. (2018). The Technical Efficiency of Tunisian Ports: Comparing Data Envelopment Analysis and Stochastic Frontier Analysis Scores. *Logistics & Sustainable Transport*, *9*(2), 73-84.

Kalirajan, K. P., & Shand, R. T. (1989). A generalized measure of technical efficiency. *Applied Economics*, *21*(1), 25-34.

Katharakis, G., Katharaki, M., & Katostaras, T. (2014). An empirical study of comparing DEA and SFA methods to measure hospital units' efficiency. *International Journal of Operational Research*, *21*(3), 341-364.

Kebede, T. A. (2001). Farm household technical efficiency: A stochastic frontier analysis. *A study of Rice producers in Mardi Watershed in the Western Development Region of Nepal, (unpublished Master's Thesis, Agricultural University of Norway, Norway)*.

Khai, H. V., & Yabe, M. (2011). Technical Efficiency Analysis of Rice Production in Vietnam. *Journal of ISSAAS*, *17*(1), 135–146.

Kodde, D. and Palm, F. (1986) Wald Criteria for Jointly Testing Equality and Inequality Restrictions. Econometrica, 54(5) 1243-1248. http://dx.doi.org/10.2307/1912331

Kokkinou, A. Geo. (2009). *Stochastic frontier analysis: Empirical evidence on Greek productivity. Glasgow. University of Glasgow*.

Koopmans, T. C. T. C. (1951). Efficient allocation of resources. Econometrica. *Journal of Econometric Society, 19*(4), 455–465.

Kopp, R. J., & Smith, V. K. (1980). Frontier production function estimates for steam electric generation technology: a comparative analysis. *Southern Economic Journal*, *46*(4), 1049–1059.

Kriger, C. E. (2005). Mapping the history of cotton textile production in precolonial West Africa. *African Economic History*, 1(33), 87-116.

Kumbhakar, S. C. (2002). Specification and estimation of production risk, risk preferences and technical efficiency. *American Journal of Agricultural Economics*, *84*(1), 8–22.

Kumbhakar, S. C., & Tveterås, R. (2003). Risk preferences, production risk and firm heterogeneity. *Scandinavian Journal of Economics*, *105*(2), 275-293.

Lim, S. H. (2014). *Tsai Ming-liang and a Cinema of Slowness*. University of Hawai'i Press.

Liu, E. M., & Huang, J. (2013). Risk preferences and pesticide use by cotton farmers in China. *Journal of Development Economics*, 100(*103)*, 202-215.

Love, H. A. &, & Buccola, S. T. (1991). Joint risk preference-technology estimation with a primal system. *American Journal of Agricultural Economics*, *73*(3), 765.

Madau, Fabio A. (2012): *Technical and scale efficiency in the Italian Citrus Farming: A comparison between Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA) Models*.

Mahjoor, A. A. (2013). Technical, allocative and economic efficiencies of broiler farms in Fars Province, Iran: A data envelopment analysis (DEA) approach. *World Applied Sciences Journal*, *21*(10), 1427-1435.

Mailena, L., Shamsudin, M. N., Radam, A., & Mohamed, Z. (2014). Efficiency of rice farms and its determinants: Application of stochastic frontier analysis. *Trends and Applied Sciences Research*, 9(7*):* 360-371.

Makinde, D. O., Fajuyigbe, M. O., & Ajiboye, O. J. (2015). Nigerian textile industry: A tool for actualising economic stability and national development. *European Journal of Business and Social Sciences*, *4*(8), 331-344.

Mawa, L. I., Kavoi, M. M., Baltenweck, I., & Poole, J. (2014). Profit efficiency of dairy farmers in Kenya: An application to smallholder farmers in Rift Valley and Central Province. *Journal of Development and Agricultural Economics*, *6*(11), 455-465.

McNicoll, G. (2001). International Fund for Agricultural Development. *Population and Development Review*, *27*(1), 196-196.

Meeusen, W., & van Den Broeck, J. (1977). Efficiency estimation from Cobb-Douglas production functions with composed error. *International economic review*, 20(2), 435-444.

Minh, N. K., & Long, G. T. (2005). Efficiency of construction firms in Vietnam: *Paper* assessment by parametric and non-parametric approach. *Munich Personal RePec Archive (968)*, 44-59.

National Bureau of Statistics. (2015). Nigeria in 2014: Economic Review and 2015-2017 Outlook.

Nazari, M. R., & Hassan, M. S. B. H. (2011). The role of television in the enhancement of farmers' agricultural knowledge. *African Journal of Agricultural Research*, *6*(4), 931-936.

Nganga, S. K., Kungu, J., De Ridder, N., & Herrero, M. (2010). Profit efficiency among Kenyan smallholders milk producers: A case study of Meru-South district, Kenya. *African Journal of Agricultural Research*, *5*(5), 332-337.

Norman, D. W. (1973). Methodology and problems of farm management investigations: experiences from northern Nigeria. *Methodology and problems of farm management investigations: experiences from northern Nigeria.*

Odedokun, V. O.,(2015). *Economic analysis of cotton production and supply trend estimation in Zamfara, State*(*unpublished PhD Thesis,Department of Agricultural Economic and Extension, ABU, Zaria.*

Odedokun, V. O., Ahmed, B., & Atala, T. K. (2015). Evaluation of parametric technique of technical efficiency measurement: application to smallholder cotton farmers in Zamfara State, Nigeria. *International Journal of Current Research and Review*, *7*(11), 65.

Odedokun, V. O., Ahmed, B., Omolehin, R. A., & Atala, T. K. (2015). Application of grafted polynomial model as approximating functions in forecasting cotton production trends in Zamfara State, Nigeria [1995-2013]. *International Journal of Current Research and Review*, *7*(16), 68.

Ofori-Bah, A., & Asafu-Adjaye, J. (2011). Scope economies and technical efficiency of cocoa agroforesty systems in Ghana. *Ecological Economics*, *70*(8), 1508–1518.

Ogundari, K., & Akinbogun, O. O. (2010). Modeling technical efficiency with production risk: A study of fish farms in Nigeria. *Marine Resource Economics*, *25*(3), 295-308.

Ogundari, K., & Ojo, S. O. (2007). An examination of technical, economic and allocative Efficiency of small farms: The case study of cassava farmers in Osun State of Nigeria. *Bulgarian Journal of Agricultural Science*, *13*(2), 185.

Ogundele, F. O., & Okoruwa, V. O. (2004). Comparative analysis of technical efficiency between traditional and improved rice variety farmers in Nigeria. *African journal of economic policy*, *11*(1), 91-108.

Ogundele, O. O., & Okoruwa, V. O. (2006). Technical efficiency differentials in rice production technologies in Nigeria.

Ogunlela, V. B. (2004, May). Improved technologies for increased production in Nigeria. In *Train the Trainer Workshop on Presidential Initiative on Vegetable Oils, Cotton and Groundnut Production. Lake Chad Research Institute*, 10-12.

Ogunniyi, L. T. (2011). Profit efficiency among Maize producers in Oyo State, Nigeria. *ARPN Journal of Agricultural and Biological Sciences*, *6*(11), 11–17.

Okike, I. (2000). Crop-livestock interaction and economic efficiency of farmers in the Savanna Zone of Nigeria. *Unpublished Ph. D Thesis, Department of Agricultural Economics, University of Ibadan*.

Oladimeji, Y. U., & Abdulsalam, Z. (2013). Analysis of technical efficiency and its determinants among small scale rice farmers in Patigi local government area of Kwara state, Nigeria. *Journal of Agriculture and Veterinary Science*, *3*(3), 34-39.

Ologbon, O. A. C., Ikheloa, E. E., & Akerele, E. O. (2012). Adoption of 'Ofada'rice variety and technical efficiency of rice-based production systems in Ogun state, Nigeria. *World Journal of Agricultural Sciences*, *8*(6), 624-631.

Onu, J. I., & Edon, A. (2009). Comparative economic analysis of improved and local cassava varieties in selected Local Government Areas of Taraba State, Nigeria. *Journal of Social Sciences*, *19*(3), 213-217.

Onumah, E. E., & Acquah, H. D. (2010). Frontier analysis of aquaculture farms in theSouthern sector of Ghana. *World Applied Sciences Journal*, *9*(7), 826-835.

Ovwigho, B.O, (2014) Factors Influencing Involvement in Non-Farm Income Generating Activities Among Local Farmers: The Case of Ughelli South Local Government Area of Delta State, Nigeria. *Journal of Sustainable Agriculture Research, 3(1), 76-84*

Pavelescu, F. M. (2011). Some aspects of the translog production function estimation. *Romanian Journal of Economics*, *32*(1), 41.

Pevcin, P. (2014). Efficiency levels of sub-national governments: a comparison of SFA and DEA estimations. *The TQM Journal*, *26*(3), 275-283.

Picazo- Tadeo, A. J., & Wall, A. (2011). Production risk, risk aversion and the determination of risk attitudes among Spanish rice producers. *Agricultural Economics*, *42*(4), 451-464.

Pope, R.D. & Just, R. E. (1991). On testing the structure of risk preferences in agricultural supply analysis. *American Journal of Agricultural Economics, 73(3), 743-748.*

Pope, R.D. & Kramer, R. A. . (1979). Production Uncertainty and Factor Demands for the competitive firm. *Southern Economic Journal*, *46*(2), 489–501.

Rahman, K. M. M., Mia, M. I. A., & Bhuiyan, M. K. J. (2012). A stochastic frontier approach to model technical efficiency of rice farmers in Bangladesh: An empirical analysis. *The Agriculturists*, *10*(2), 9-19

Rahman, S. (2003). Profit efficiency among Bangladeshi rice farmers. *Food policy*, *28*(5), 487-503.

Read, L. E. (1998). *A comparison of data envelopment analysis and stochastic frontiers as methods for assessing the efficiencies of organisational units* (Doctoral dissertation, University of Warwick).

Reinhard, S., Lovell, C. K., & Thijssen, G. J. (2000). Environmental efficiency with multiple environmentally detrimental variables; estimated with SFA and DEA. *European Journal of Operational Research*, *121*(2), 287-303.

Sadiq, M. S. (2015). Application of Dual Stochastic Production Function in Estimating Technical Efficiency in Cotton Production in Kano State, Nigeria. *Krishi Sanskriti Publications, 2(3), 393-397.*

Sadoulet, E., & De Janvry, A. (1996). *Quantitative development policy analysis* (1). Baltimore: Johns Hopkins University Press.

Sani, A. (2012). Reviving Cotton Production in Nigeria. *The Tide News Online*.

Sekumade, A. B. (2009). The effects of petroleum dependency on agricultural trade in Nigeria: An error correlation modeling (ECM) approach. *Scientific Research and Essay*, *4*(11), 1385-1391.

Shafiq, M., & Rehman, T. (2000). The extent of resource use inefficiencies in cotton production in Pakistan's Punjab: an application of Data Envelopment Analysis. *Agricultural Economics*, *22*(3), 321-330.

Sharma, K. R., Leung, P., & Zaleski, H. M. (1999). Technical, allocative and economic efficiencies in swine production in Hawaii: a comparison of parametric and nonparametric approaches. *Agricultural economics*, *20*(1), 23-35.

Spedding, C. (2012). *An introduction to agricultural systems. Netherlands*: Springer Science and Business Media.

Solakoglu, M. N. (2013). The role of gender diversity on firm performance: a regression quantile approach. *Applied Economics Letters*, *20*(17), 1562-1566.

Taylor, T. G., Drummond, H. E., & Gomes, A. T. (1986). Agricultural Credit programs and production effciency: an analysis of traditional farming in Southeastern MInas Gerais, Brazil. *American Journal of Agricultural Economics.*, *68*(1), 110–119.

Theodoridis, A. M., & Anwar, M. M. (2011). A comparison of DEA and SFA methods: a case study of farm households in Bangladesh. *The Journal of Developing Areas*, 95-110.

Thrall, R. M. (1996). Duality, classification and slacks in DEA. *Annals of Operations Research*, *66*(2), 109-138.

Tiedemann, T., & Latacz- Lohmann, U. (2013). Production risk and technical efficiency in organic and conventional agriculture–the case of arable farms in Germany. *Journal of Agricultural Economics*, *64*(1), 73-96.

Tveterås, F. A. and R. (1999). Modeling Production risk with a two-step procedure. *Journal of Agricultural and Resource Economics*, *24*(2), 424–439.

Udoh, E. J., & Akpan, S. B. (2007). Measuring technical efficiency of water leaf (Talinum triangulare) production in Akwa Ibom State, Nigeria. *American Eurasian Journal of Agriculture and Environment Science*, *2*(5), 518-522.

Villano, R., & Fleming, E. (2006). Technical inefficiency and production risk in rice farming: evidence from Central Luzon Philippines. *Asian economic journal*, *20*(1), 29-46.

Wadud, A., & White, B. (2000). Farm household efficiency in Bangladesh: a comparison of stochastic frontier and DEA methods. *Applied economics*, *32*(13), 1665-1673.

Wakili, A. M. (2012). Technical Efficiency of Maize Farmers in Gombi Local Government of Adamawa State, Nigeria. *Agricultural Journal*, *7*(1), 1-4.

Wanda, O. (2009). Production risk and input use in banana production in Uganda. *A Thesis for the Degree of Master of Science in Agricultural and Applied Economics of Makerere University*.

Wang, J., Wailes, E.J., & Cramer, G. L., & Jirong Wang, E. J. W. and G. L. C. (1996). A shadow-price frontier measurement of profit efficiency in Chinese agriculture. *American Journal of Agricultural Economics*, *78*(1), 146–156.

Watkins, K. B., Hristovska, T., Mazzanti, R., Wilson, C. E., & Schmidt, L. (2014). in Measurement of technical, allocative, economic, and scale efficiency of rice production Arkansas using data envelopment analysis. *Journal of Agricultural and Applied Economics*, *46*(1), 89-106.

Wik*, M., Aragie Kebede, T., Bergland, O., & Holden, S. T. (2004). On the measurement of risk aversion from experimental data. *Applied Economics*, *36*(21), 2443-2451.

Xu, X., & Jeffrey, S. R. (1998). Efficiency and technical progress in traditional and modern agriculture: evidence from rice production in China. *Agricultural economics*, *18*(2), 157-165.

Yamane, T. (1973). Statistics: *An introductory analysis, 2nd Ed. New York: Harper & Row.*

Yusuf, S. A., & Malomo, O. (2007). Technical efficiency of poultry egg production in Ogun state: a data envelopment analysis (DEA) approach. *International journal of poultry science*, *6*(9), 622-629.

Zhang, Y. (2002). The impacts of economic reform on the efficiency of silviculture: a non-parametric approach. *Environment and Development Economics*, *7*(1), 107-122.

BIODATA OF STUDENT

Muhammad Bala was born in Jalingo, Taraba State, Nigeria on the 31th August, 1974. He obtained his Bachelor of Science Degree (B. Sc.) in Economic from Ahmadu Bello University, Zaria and Master of Science (M.Sc.) in Agricultural Economics from Modibbo Adama University of Technology, Yola, Nigeria. He is currently an assistant Lecturer at Taraba State University, Jalingo. Bala has attended conferences and published numerous research articles in both reputable national and international journals. His research interestarea production, risk management, marketing, technological change and resource economics. He likes reading, writing, preaching and travelling and is married and blessed with four children.

152

LIST OF PUBLICATIONS

Muhammad Bala, Mad Nasir Shamsudin, Alias Radam and Ismail Abd Latif (2018). Profit Efficiency Among Cotton Farmers: A Cobb-Douglass Stochastic Frontier Production Function Analysis. *Journal of Asis Scientific Research 8(7): 237-246.*

Muhammad Bala, Mad Nasir Shamsudin, Alias Radam and Ismail Abd Latif (2019). Measuring the technical efficiency of cotton farmers using stochastic frontier and data envelopment analysis: A case study of Northeast zone, Nigeria. *IOSR Journals of Agriculture and Veterinary Science 12(5):08-15.*

Muhammad Bala, Mad Nasir Shamsudin, Alias Radam and Ismail Abd Latif (2018). Efficiency analysis of cotton production: a case study of gassol and lau local government of Taraba State, Nigeria. *E3S Web of Conferences **52**, 00030 (2018)*

UNIVERSITI PUTRA MALAYSIA

STATUS CONFIRMATION FOR THESIS / PROJECT REPORT AND COPYRIGHT

ACADEMIC SESSION : _____

TITLE OF THESIS / PROJECT REPORT :

PRODUCTION RISK AND TECHNICAL EFFICIENCY OF COTTON PRODUCTION IN _____

NORTHEAST ZONE OF NIGERIA _____

NAME OF STUDENT : MUHAMMAD BALA

I acknowledge that the copyright and other intellectual property in the thesis/project report belonged to Universiti Putra Malaysia and I agree to allow this thesis/project report to be placed at the library under the following terms:

1. This thesis/project report is the property of Universiti Putra Malaysia.

2. The library of Universiti Putra Malaysia has the right to make copies for educational purposes only.

3. The library of Universiti Putra Malaysia is allowed to make copies of this thesis for academic exchange.

I declare that this thesis is classified as :

*Please tick (√)

☐	**CONFIDENTIAL**	(Contain confidential information under Official Secret Act 1972).
☐	**RESTRICTED**	(Contains restricted information as specified by the organization/institution where research was done).
☐	**OPEN ACCESS**	I agree that my thesis/project report to be published as hard copy or online open access.

This thesis is submitted for :

☐ **PATENT**   Embargo from_____ until _____
                        (date)   (date)

Approved by:

_____   _____
(Signature of Student)   (Signature of Chairman of Supervisory Committee)
New IC No/ Passport No.:   Name:

Date :   Date :

[Note : If the thesis is CONFIDENTIAL or RESTRICTED, please attach with the letter from the organization/institution with period and reasons for confidentially or restricted.]