بسم الله الرحمن الرحيم

Sudan University of Science and Technology

College of Graduate Studies

Analysis of Growth and Instability of Crop Production in Mechanized Rain-Fed Sector in Gedarif Area

تحليل النمو والتذبذب لإنتاج المحاصيل في قطاع الزراعة المطرية الآلية في منطقة القضارف

A Thesis Submitted for in partial Fulfillment of the Requirements for degree of Master Science in Agricultural Economics

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الآية

بسم الله الرحمن الرحيم

قال تعالى:

(أَوَلَمْ يَرَوْا أَنَّا نَسُوقُ الْمَاءَ إِلَى الْأَرْضِ الْجُرُزِ فَنُخْرِجُ بِهِ زَرْعًا تَأْكُلُ مِنْهُ أَنْعَامُهُمْ وَأَنْفُسُهُمْ أَفَلا يُبْصِرُونَ).

صدق الله العظيم

سورة السجدة الآية (٢٧)

DEDICATION

To my father , Elteyp

To my lovely mother Teypa

To my brothers, sisters and friends

To everyone who helped me at any time

I dedicate this work with love and respect

Um Elhussein

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Abstract

Gedarif state is the largest and oldest mechanized rain-fed farms in Sudan. The main crops produced in the state are sorghum and sesame which covered 30% and 17% of the total cultivated area in the country, respectively (Arafat, 2010).

The studies is focused on weather, the extent and nature of growth that has actually taken place and examine the extent of yield variability in Gedarif consequent after to adoption of price liberalization policy period. The study cover the Pre- price liberalization policy period, i.e.1997/80 to 1991/92 and the Post- price liberalization policy period, i.e.1992/93 to 2011/2012. Analysis is based on secondary data on area, production, productivity and rainfall of sorghum and sesame ,that taken from the department of statistical and planning agriculture, ministry of agricultural, forests and irrigation, Gedarif, and Bank of Sudan.

In this study applied regression model and standard to measure the growth are and the percentage of fluctuation of agricultural production and the relationship between them by using (SPSS) and (EXCELL)

The findings of the study are follows-:

- Change in agriculture production are due to fluctuation in productivity per feddan which influenced not only by price policies, also environmental factors such as amount and distribution of rain fall, pests, diseases and technology used in production.

- Increasing fluctuation rate of agriculture production due to change in area and productivity.

- The instability in area and productivity of most crops move in the same direction, and their increasing /decreasing trend resulted in increasing /decreasing in stability.

So as, it may be said that the increase in area and productivity would accompany the increase in instability also, but an increase in production to increase in productivity would help decreasing production instability. Relationship between growth and instability indicated that the increase in production due to increase in productivity had positive relationship but the increase in production due to increase in area and productivity had negative relationship between growth and instability in production of particular crop.

According to these results. The study recommended:

- Vertical expansion for sorghum and sesame using improving samples.

- To rehabilitate the infrastructure of mechanized rain-fed in Gedarif .

- The stability in production may be achieved by increasing productivity without decline in area in particular crop.

-The investment in agricultural research and keeping favorable agricultural prices policies we can achieve stability in production.

الخلاصة

ولاية القضارف هي أكبر وأقدم قطاعات الزراعة الآلية في السودان . المحاصيل الرئيسية التي تنتج بالولاية الذرة والسمسم والتي تغطي حوالي ٣٠% و١٧% من جملة المساحة المزروعة بالسودان.

ركزت هذه الدراسة على معرفة مدى و طبيعة النمو الذي يحدث فعلا ودراسة مدى تقلب الانتاج بمنطقة القضارف نتيجة لتطبيق سياسة التحرير الاقتصادي . تغطي الدراسة الفترة من موسم (٨٠-١٩٧٩) الى (٩٢-١٩٩١) قبل سياسة تحرير الاسعار والفترة(٩٣- ١٩٩٢) الى (١٢-٢٠١١) بعد تطبيق سياسة تحرير الاسعار.

يستند التحليل على البيانات الثانوية المتمثلة في بيانات السلاسل الزمنية للمساحات المزروعة والانتاج و الانتاجية ومعدلات الامطار بالقضارف (الذرة والسمسم) ماخوذة من قسم الاحصاء الزراعي ، ادارة التخطيط الزراعي- وزارة الزراعة والغابات والري القضارف وبنك السودان .

في هذه الدراسة تطبيق نمازج الانحدار والانحراف المعياري لقياس معدلات النمو ونسبة تذبب الانتاج الزراعي) و والعلاقة بينهما باستخدام (SPSS,EXCELL).

اوجدت الدراسة الاتي:

- يعزى تغير الانتاج الزراعي لتذبذب الانتاجية للفدان والتي غير السياسات السعرية تتاثر بالعوامل الطبيعية مثل كمية وتوزيع الامطار والافات والامراض وكذلك التكنولوجيا المستخدمة في الانتاج

- تحدث ذيادة في معدل تذبذب النتاج الزراعي نتيجة للتغير في المساحات المزروعة ومتوسط الانتاجية

- اتجاه معدل التذبذب للمساحة المزروعة ومتوسط الانتاج يسير بنفس الاتجاه وان اي زيادة/ نقص في المساحات المزروعة ومتوسط الانتاج تؤدي الى زيادة / نقص في معدل التذبذب للانتاج الزراعي .

لذلك يمكننا القول ان زيادة المساحة والانتاجية تقود لزيادة التذبذب ، لكن زيادة الانتاج لزيادة الانتاجية تساعد في نقص التذبذب ، العلاقة بين معدل النمو ونسبة التذبذب تشير تكون موجبة اذا كان زيادة الانتاج تتاثر بمتوسط الانتاجية فقط بينما تكون سالبة اذا كانت زيادة الانتاج تتاثر بالزيادة في متوسط الانتاج والمساحة معا .

أوصت الدراسة بالاتي:

- التوسع الرأسي للذرة الرفيعة والسمسم باستخدام اصناف محسنة.
- لرفع كفاءة الانتاج في الزراعة الالية يجب اعادة تعمير بنيته التحتية لهيئة الزراعة الالية في القضارف .
- الاستقرار في الانتاج عن طريق زيادة الإنتاجية دون تراجع في المساحة في محصول معين .
- الاستثمار في البحوث الزراعية والحفاظ على سياسات مواتية الأسعار الزراعية يمكننا تحقيق الاستقرار في الإنتاج.

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CHAPTER ONE

1.1 Introduction:

Sudan is one of the richest countries in the world in terms of its huge natural resources, abundant surface and underground water, vast fertile land, and enormous animal resources. These endowments categorized Sudan as a potential country for world food security and pushed (FAO) to call Sudan the world food basket. According to latest national census, the total population of Sudan was 33.42 million heads with an annual growth rate of 2.8% (Ministry of Information, 2011).

This population figure indicated that this country is among the least congested area of the world (total area of Sudan is estimated at 1.9 million square km).Slightly less than half of the population of country is women (Ministry of Information, 2011).

The agricultural sector dominates the economy of Sudan, it provides large share of inputs for the countries agro-industries (Bank of Sudan, 2003).The total area used in agriculture is estimated at 187,800 1000 hectare and only about 50.235.4 1000 feddan are utilized in agricultural production. Tables (1.1) explain that the total area 446.964 1000 feddan , about 9.078.9 is not utilized land, 42,840 is forests, 11,470,352 is pastures (AOAD, 2012).

Table 1. 1: Land use in Sudan 2012.

Item	Area(000)Ha	(000)feddan
Total area	187,800	446,964
Not utilized land	3814.66	9,078.9
Irrigated sector	205.80	489.8
Rain-fed sector	1.68	3.9984
Total of cultivated land	21107.32	50,235.4
Total of pastures land	48194,76	11,470,352
Total of Forests land	18000	42,840

Source: Arab organization for Agric Development, Khartoum. 2012.

The country enjoys a high potentiality to produce a wide range of crops including wheat, beans, dates, various fruits and vegetables in the far north besides cotton, groundnuts, sorghum and sesame in the central plains. These crops are produced under two different farming systems namely: the rain-fed and irrigated systems.(Akram , 2008).

Table (1.2) shows that the agricultures share of GDP and growth rate was estimated at 37%in early 1980's and witnessed a decline to 28% during mid 1980 and early 1990's due to severe droughts and government policies that adversely affected the performance. A rebound was achieved during early 2000, when agriculture reached 47%of GDP, mainly due to favorable climatic conditions; again it decreased to 43.4%during the period 2001-2006.

According to table (1.2),the agricultural sector witnessed an appreciable growth rate form an average of 2.3%per annum during the period of 1981-90 to a peak of 12.1%per annum during the period of 1991 -99and then a decline to an average of 6.4% during the period from 2011-2012.

Table 1. 2: The contribution of agricultural sector to (GDP) and (growth rate)

Season	Percentage share to GDP (%)	Growth Rate (%)
1990\91	28.7	4.3
1991\92	33.9	15.6
1992\93	38.1	26.4
1993\94	40.0	12.7
1994\95	43.1	17.7
1995\96	43.0	9.3
1996\97	45.0	9.6
1997\98	47.4	12.3
1998\99	48.7	8.5
1999\20	46.6	0.8
2000\01	45.6	12.1
2001\02	46.0	7.3
2002\03	45.6	5.2
2003\04	44.5	4.5
2004\05	39.6	7.2
2005\06	39.2	8.3
2006\07	36.2	2.4
2007\08	35.9	5.1
2008\09	13.1	6.7
2009\10	13.3	6.7
2010\11	13.5	3.3
2011\12	30.4	6.4

Source: Central bank of Sudan , annual reports (1991-2012)

In Sudan, there are three major farming systems:

1\ Irrigated farming. 2\ Mechanized farming and 3\ Traditional farming.

Gedarif state the mechanized rain-fed farms are the largest and oldest in Sudan. And extends between latitudes 12 40 and 15 45 N and longitudes 33 34 and 37 10 over 75263 km .It is located in the southern part of kassala state in eastern Sudan and the boundary of Ethiopia and Eritrea, and from Eastern direction and southeast the states of Gezira and Sennar and shares the boundary with Khartoum state in the southeast. Its elevation is about 600 meters above the

mean sea level. It lies between major of Blue Nile, the Rahad River and Atbara River. Gedarif state is the main center for grain production in Sudan, where the state contributes more than 50 % of the production of sorghum in Sudan. Agriculture depends entirely on rain water. (MOAF,Gedarif, Agriculture Guide 20١٢)

1.2 Problem statement:

The problem focused around the nature of growth-instability relationship in different environmental situation. The agricultural population has undergone radical change in most of the developing countries .The new agricultural technology has introduced greater variability in crop output along with the upward shift in productivity In and production .Year to year fluctuations in crop output generate instability which has far reaching economic implication particularly in under-developed and developing countries. The problem of instability and growth in agricultural production has engaged the attention of scientists and planners in the recent past, and has led to the development of various statistical techniques for measurement of instability and growth in crop output. The present study is planned to examine the agricultural growth and instability during the post- prices liberalization policy in Gedarif .The study would have far-reaching implication for the planners, policy-makers and promotes of change for formulating strategies for agricultural development in Gedarif state.

1.3 Objectives of the study:

The main objective of the study is to investigate the extent and nature of growth and examine the extent of yield variability in mechanized rain fed se Gedarif state after adoption of liberalization policy.

The specific objectives are:

- To study the growth rates in area, production and productivity of sorghum and sesame in mechanized rain fed, in Gedarif state.
- To measure the extent of instability in the production of sorghum and sesame in the mechanized rain fed during the period under study.
- To investigate the kind of relationship between growth and instability in the crops.
- To investigate the relationship between rainfall and instability across crops.

1.4 Research Hypotheses:

- The liberalization price policy has to increased crop production in mechanized rain fed in Gedarif state.
- The liberalization price policy has made the crop production more stable.
- There is high growth in crop production compared with low instability in different periods (pre-post liberalization policy).
- The rainfall effected in instability

1.5 Organization of the study:

The first chapter is the introduction including problem statement, objectives of the study research hypothesis. And organization of the study. The second chapter is review of literature .The third chapter covers the agro-economic background of the mechanized rain fed including research methodology, period of study, and analytical model (regression analysis).The findings and discussions of the analysis of growth of agricultural production .And instability in production of sorghum and sesame, are resulted in chapter four .Chapter five contains the summary and conclusions and recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Studies in instability in agricultural production:

Mohamed et.al (2010), in studying "Analysis of the Effect of Price Liberalization Policy on Production of the Main Crops Grown in New Halfa Agricultural Corporation", mentioned that sorghum and wheat witnessed a continuous increase in instability during the two periods. The instability in groundnuts was high during the pre-liberalization policy and less during post-liberalization policy. The instability in cotton decreased during post-liberalization policy. The decomposition analysis of sources of change in mean production indicated that the main contribution of change in mean production was change in mean area in wheat, cotton, groundnuts and in sorghum was due to change in mean yield. The change in the variance of yield accounted for large shares of the changes in the variance of production of cotton. The changes in the variance of area accounted for large shares for wheat and sorghum. The change in the area and residual term were important in explaining the changes in the variance of production of groundnuts.

Akram (2008), in studying "The effect of price liberalization on instability & Growth of Agricultural Production : A case Study of Gezira Scheme'' in his study focused on ,the extent and nature of growth that has actually taken place and examine the extent of yield variability in Gezira scheme consequent after to adoption of price liberalization policy period. And mentioned that changes in agricultural production are result fluctuations in productivity per feddan due to by price policies, also

environmental factors. Increasing fluctuation rate of agricultural production due to change in area and productivity. The instability in area and productivity of most crops move in the same direction, and their increasing/decreasing trend resulted in increase/decrease in instability. Relationship between growth and instability indicated that the increase in production due to an increase in productivity.

Ayako,(2011), in this paper examines the Southern region state-wise trend of total factor productivity (TFP) growth in Indian manufacturing sector for the periods 1984-85 to 2004-05. Kendrick index is used to compute total factor productivity index. The resulting information is used to examine whether the post-reform period shows any improvement in productivity in comparison to the pre-reform one. Findings of the present study indicate that total factor productivity growth of Indian manufacturing sector for all states combined and selected South region states have declined during the post-reforms period as compared to the pre-reforms period. Further, growth of gross value added (GVA) in India. It is also found that there is a tendency of convergence in terms of TFP growth rate among Indian states during the post-reform years and only the states that were technically efficient at the beginning of the reform remain innovative.

Ruttan (2002), in his study "Productivity growth in world agriculture: sources and constraints", mentioned that, the main constraints which affect productivity growth are environmental and resource constraints and scientific and technical constraints. The leading resource and environmental constraints faced by the world farmers include soil loss and degradation, water logging and salinity; the co-evolution of pests; pathogens and hosts; and the impact of climate change. He also

mentioned that the share of research budgets devoted to maintenance research-the research needed to maintain existing crop and animal productivity levels- have raised relative to total research budgets, so that cost per scientist year has been rising faster than the general level price.

Mohamed *et. al* (2010), in study "The Effect of Price Liberalization Policy on Agricultural Production Instability in Rahad Agricultural Corporation", mentioned that sorghum witnessed a continuous increase in instability during the periods before and after adoption of prices liberalization policy. The instability in groundnuts and cotton production was observed after the adoption of liberalization policy. The instability in area and productivity of the three crops moved in the same direction and their increasing/decreasing trend resulted in increase/decrease in instability. The decomposition analysis of sources of change in mean production indicated that the main contribution in change of mean production of sorghum and groundnuts was due to change in mean yield and due to change in mean area in case of cotton.

Tayfour (1994), discussed the agricultural price policy and its role on the agricultural production in Gezira scheme in terms of profitability. The study shows that the Gezira scheme major crops ranked in the order: groundnuts, cotton, sorghum and wheat in terms of both relative and absolute competiveness. In terms of private profitability groundnuts earned the highest private profitability while cotton, wheat and sorghum have low. All crops in scheme are taxed except sorghum and the tax burden after Liberalization policy was less than before it. Season 1991/92 is better than season 1992/93 in terms of competiveness. Economic profitability outstripped private profitability for all crops

indicating the government price policy is taxing the efficient crops production of the scheme.

ElKhalifa (1994), examined the incidence of agricultural price policy on sorghum and sesame production and export in Damazin area for the season 1992/93.Competitveness, profitability and price incentives for each of these crops were examined. The results obtained show that both sorghum and sesame were competitive in the season 1992/93. But, sorghum unlike sesame shoed poor competitive ability in the two other season (89/90-91/92).Despite the extensive set of liberalization policy adopted in1992/93, but profitability of both sorghum and sesame have not any significant improvement. Also, the results indicate high taxes in the agricultural crops. The sensitivity analysis for yield of both crops revealed that both crops are sensitive to any little change in yield.

Amal (1996),in study "Instability in Agricultural Production and its Effects on Farmers' Income" in her study in investigates the causes of fluctuations in output and prices of the major agricultural commodities being the main factors behind the low and unstable net income of agricultural producer. And found change in agricultural production is mainly due to fluctuations in productivity per Fadden which is influenced not only by technology but also by environmental factors. Fluctuations in production, yield and area are more pronounced in traditional rain fed crops less than mechanized rain fed crops and Producer prices of export crops heavily than those of food crops.

Alawia, 1995 study ''Factors Affecting Sorghum Productivity In the Mechanized Rain fed Schemes'', Gedarif , Damain, and Dillinj. Study focused. On the main factors affecting sorghum productivity in the

mechanized rain fed schemes. The results show that June, August and September rainfall have positive impact on sorghum yields. This was mainly attributed to the expansion in virgin fertile soils. Regional differences have a negative impact on sorghum yields.

2.2 Stages of agricultural Policies in Sudan:

First Stage: Before Economic Liberalization. (1970/71-1990/91)

• The most important Policies is:

• Vertical expansion in agricultural rainfed sector. The public sector emphasized on agricultural production especially economic development Negative impacts of low investment policy (1970-1982/83) reflected in low economic growth rate estimated at 1.3 through the 60th• , the lowest economic growth rate compared to other countries which was 3% at average (source: World Bank, 1979).

Republic of Sudan declared agricultural policies, Comprehensive Development Concept which started in the implementation of the Fifth plan (1970/71-1974/75) it extended till 1976/77.Its main objective was to increase economic growth rate, it increased reaching *4-5%* during the plan in spite its main objective to reach economic growth rate of 7.6%. Negative impacts were (1970-1977) increasing of imports and decreasing in exports.

- Coming at the top for trade exchange with European countries (at the top for imports and exports) then Saudia Arabia, Japan, China, Western European countries, USA, USAR land Egypt.
- Imports European Union countries, USA, Egypt, Japan, Western European countries, India Arabic countries (Egypt, Saudia Arabia, Iraq).Sudan redirecting of its exports to European Union, China. Expanding its trade with European countries, Asia especially Japan and China.
- The 6th Plan (1976/77-1982/83):

  Investment policy implemented depending on foreign finance

(loans and grants from Arabic Funds for Economical Social Growth , IFAD and other financing corporations), for development projects -Tribal Program for Financial and Economical Reform- to cover the deficit of finance resources for agricultural development projects. Arabic Funds for Economical Social Growth in its plan (1976/77- 1985/86) financing 100 projects approximately.

- The new policies were required for encouraging foreign finance especially from Arabic countries for more investment of finance.
- Little improvement of exports in the years 1978 and 1979.
- Those policies reflected on multiple exchange rates for Sudanese pound value (SP), and imbalance of Sudanese pound to stand against other hard currencies.
- New monetary policy declared by the government for economic reform that was the reduction of SD exchange price value to 20%. Two prices for SP appeared (official and nominal prices)
- At 1982 policy called for free marketing which reflected on fluctuations in prices (Price instability).(Akram 2008)
- Monetary guarantee policies due to expansion of money supply due to increasing of debts and loans for public and private sectors. The dependence on the banking finance increased for financing of the deficit of running cost.

Agricultural Development Plan, the most important policies were:

- Modernization of traditional rainfed sector
- Increasing productivity and expanding of the Mechanized rainfed Sector.

- Improving of irrigation resources.

The main objectives were:

- To achieve real growth rate of *6.5* annually.
- Increasing of crops productivity.
- Directing of the majority of finance to agricultural sector.

The Agricultural Bank provided Credits and adoption of agricultural guarantee policies and the bank also responsible for credits, marketing and storage in addition to agricultural guarantees.

The policies are:

• Liberalization of Exchange prices, agricultural inputs prices and capital commodities for more incentives provision to the producers and achievement of crop comparative advantages.

• Diversification and increasing of main crop productivity especially the exports crops.

• Integration of all policies to raise crops productivity, self-sufficiency, poverty reduction and economic stability the policies for different sectors.

Agricultural contribution to to GDP had risen from 18 percent in the 1980s to 33 percent in the 1990s with the highest contribution from livestock 21 percent followed by cash crops *6.9* percent, forestry 3.2 percent and lastly mechanized production *2.5* percent.

This fact denotes that output structure and growth of real output had moved in favor of plant and animal traditional sector, both of which had showed steady output increase since 199 1,'92. However, productivity of the sector is still very much low compared to minimum international standards. The international wheat productivity was highly increased during the Green Revolution with development and release of modem

wheat varieties in the early 1960th• The first gain in wheat productivity was seen in irrigated and high rain environments, so called favorable production environments,(Suad and Samia, 2007).

Third stage: (1998-2003.

Fourth stage: 2003-2006.

Fifth stage: Agricultural Revival (2007-2011).

CHAPTER THREE

RESEARCH METHODOLOGY

3 .1 The Study Area:-

Location:-

Gedarif state is extends between latitudes 12 40 and 15 45 N and longitudes 33 34 and 37 10 over 75263 km .It is located in the southern part of kassala state in eastern Sudan and the boundary of Ethiopia and Eritrea, and from Eastern direction and southeast the states of Gezira and Sennar and shares the boundary with Khartoum state in the southeast (MOAF, Gedarif, Agriculture Guide 20١٢).

Area:

The area of the state is about 71,000 square kilometer (17 million acres).

Population:

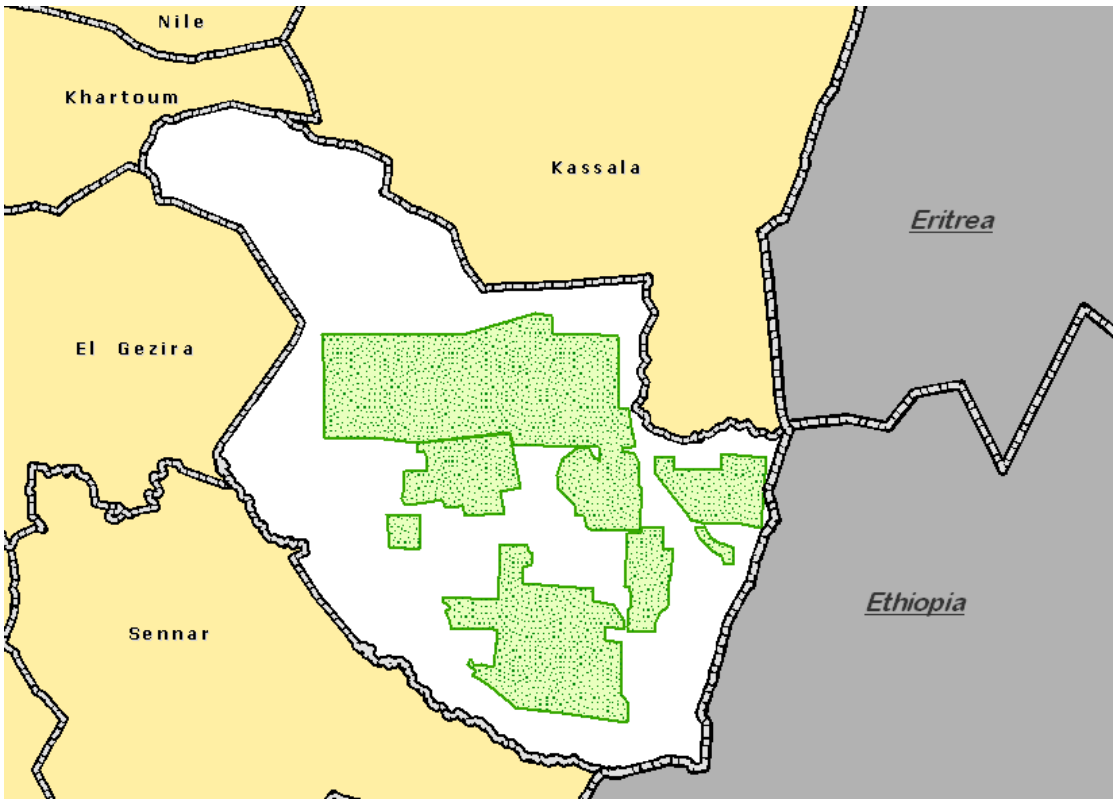
The state's population census in 2001 is about 1.783.134 heads. Population density was 18 persons per square kilometer. 88% of the population works in agriculture as a key source for their economies (MOAF,Gedarif, Agriculture Guide 20١٢) .

Gedaref State is characterized by high levels of social and ethnic diversity where the population group include, Shukriya , Lahawyien , Dabaina, Kawahla, Fur, and Bargo tribes along with northern and riverine tribes such as the Shaygyiya and Ja'alyin in addition to Bani Amir, Rashaida and Beja.

Gedarif state is the main center for grain production in Sudan, where the state contributes to more than 50 % of the production of millet and sorghum in Sudan. Agriculture depends entirely on rain water. Agricultural sector ranked the top of the productive sectors in terms of contribution to the GDP of the state. In

terms of the contribution of the various components of the agricultural sector in the total production, the livestock sector represents the largest component where its average contribution is about 75.3 % of the total agricultural output of the state. The rain-fed agriculture is the most prevalent in the geographical area where more than 65% depend on it. Forests and its products play an important role in the life of the state's population. Gum Arabic is the most important economic forest products in Sudan and one of the most important exports. Estimated natural grassland areas available in Gedarif state are about 2.4 million acres (MOAF,Gedarif, Agriculture Guide 20١٢) .

3.1.1 GADARIF STATE



Source: (MOAF,Gedarif, Agriculture Guide 20١٢).

The state is well endowed with water availability. Seasonal rivers such as the Rahad, Saiteet, Bsalam and Atbara traverse this area flowing northwards from

the Ethiopian highlands at key periods of the year. Furthermore, though the north and north-western parts of the state are semi-dry in character, with an annual average of 100-500 mm rainfall from July to October, the majority of the state receives somewhere between 500-900mm of rainfall during the same period. As such, seasonal rains support the cultivation of large areas and growth of valuable forest and grassland (Nadia , 2012).

Outside of the rainy season, Gedaref suffers from water scarcity and tension has been known to escalate over access to water points. There is a need for stronger planning and management in this sector in order to cope with seasonal fluctuation in water supply and to develop access points in a way that maximizes their utility.

Between the months of March and April the rivers and khors are usually reduced to sandy river beds. These areas do, however, continue to suffer a potable water supply via shallow wells and support small-scale production of horticultural crops for household consumption. Gedarif state also benefits from number of surface and underground water basins such as those found in Rashid and Wad Eligaili.

Gedaref state currently suffers from severe forms of ecological deterioration. The Higher Council for the Environment in Gedaref cites the reduction of forest land, pasture land, soil erosion, water shortages and reduced levels of ecological diversity as the core indicators of decline and damage in this regard.

Mechanized farming in Gedaref state constitutes the backbone of the state economy and continues to be an important source of employment for the state's inhabitants and migrant population. However, the absence of land rotation and over-cultivation of existing tracts of land have led to the deterioration of soil

quality, the decline of biodiversity and the spread of deforestation in recent years(Nadia , 2012).

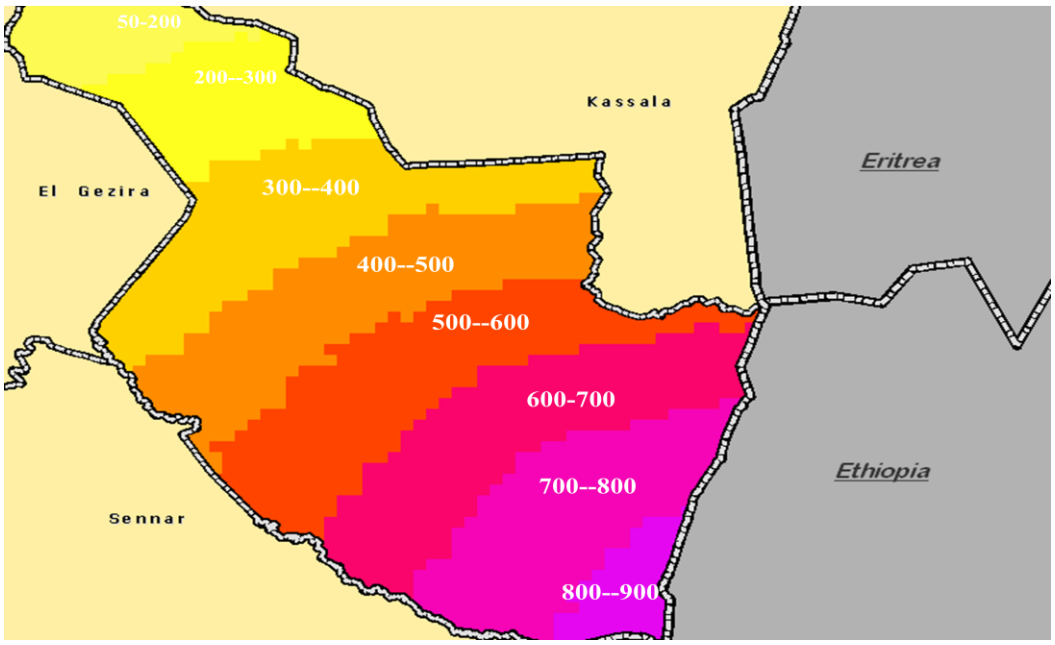
3.1.2 Soils:

The soil in Gedaref state is characterized by cover most state deep dark-colored clays of predominantly mineralogy .Clay contents 60% and can go to 85%, organic matter 0.3-2 , top soil 0.5-1.8, sub soil and verticals' have rapid infiltration rate and high hydraulic conductivity through cracks when dry, but when wet, the rate is very slow to the extent it becomes impermeable and leads to run-off or water logging and land preparation is very difficult when the soil wet (MOAF,Gedarif, Agriculture Guide 20١٢).

3.1.3 Climate:

Rainfall varies in the study area location from south to north and most of rain falls in summer in the period of May to October when the unstable air of equatorial origin reaches north . The climatic zones are classified into arid zone (200-400 mm rainfall) , semi arid zone (400-600 mm rainfall).The temperature is high in Summer and warm in winter , the lowest temperature occurs during January (15 c) and the highest in April reaching 46 c , the relative humidity varies from 24% in April and 37% in August (AbdelRahim ,2008).

3.1.4 Average Annual Rainfall, mm



Source: (MOAF,Gedarif, Agriculture Guide 20١٢).

3.1.5 Land use:

Gedarif state lies in the central clay plain of Sudan, its southern part lies south of 400mm rain line , is the one of most productive and economically important area in the Sudan since 1940. It is leading the states in mechanized rain-fed agriculture where about 3 million ha are under mechanized farming system.

Rain fed mechanized farming is major land use in the state. Other occupations include irrigated agriculture (Rahad scheme and 00000000000 wild flooding around Atbara and Rahad rivers) and semi nomadic pasture lists herding cattle,camels,sheep and goats in Botana area. (Abdel Rahim, 2008).

3.1.6 Tables below illustrates area , productivity and production for Crop production in Gedarif state:

Sorghum crop :

Season	area thousand per acre	harvested area by thousand per acre	Productivity kg / tons.	production by thousand tons
٢٠٠٦	٤٦١٩	٣٠٣٠	١٦٨.٣	٥٢١
2007	4374	3220	117,8	572,2
2008	5260	3416	180	416
2009	5871	2033	92	187
2010	6018	4514	180	812
2011	5530	2905	134	392
2012	5981	5191	266	1380

Source: (MOAF, Gedarif, Agriculture Guide 20١٢).

Sesame crop :

Season	area thousand per acre	harvested area by thousand per acre	Productivity kg / tons.	production by thousand tons
٢٠٠٦	٦١٢	٥٤٣	٨٦.٦	٤٧
2007	576	475	78	37
2008	474	457	132	62
2009	697	487	92	64
2010	637	568	128.8	73
2011	484	366	100.3	36.8
2012	829	757	169	128

Source: (MOAF ,Gedarif, Agriculture Guide 20١٢).

Millet crop:

Season	area thousand per acre	harvested area by thousand per acre	production by thousand tons	Productivity kg / tons.
٢٠٠٦	165	142	25	175
2007	130	98	12	118
2008	192	150	20	136
2009	177	109	11	100
2010	196.6	157	24	155
2011	217	194	34	177
2012	279	234	36	150

Source: (MOAF ,Gedarif, Agriculture Guide 20١٢)

Cotton crop:

Season	area thousand per acre	harvested area by thousand per acre	production by thousand tons	Productivity kg / tons.
٢٠٠٦	6.5	6	١	١٦1
2007	18	18	2.8	157
2008	20	14	1.26	89
2009	3	3	0.3	89
2010	3.8	3.8	0.5	132
2011	13	11	1.5	142
2012	8.08	4.5	0.34	76

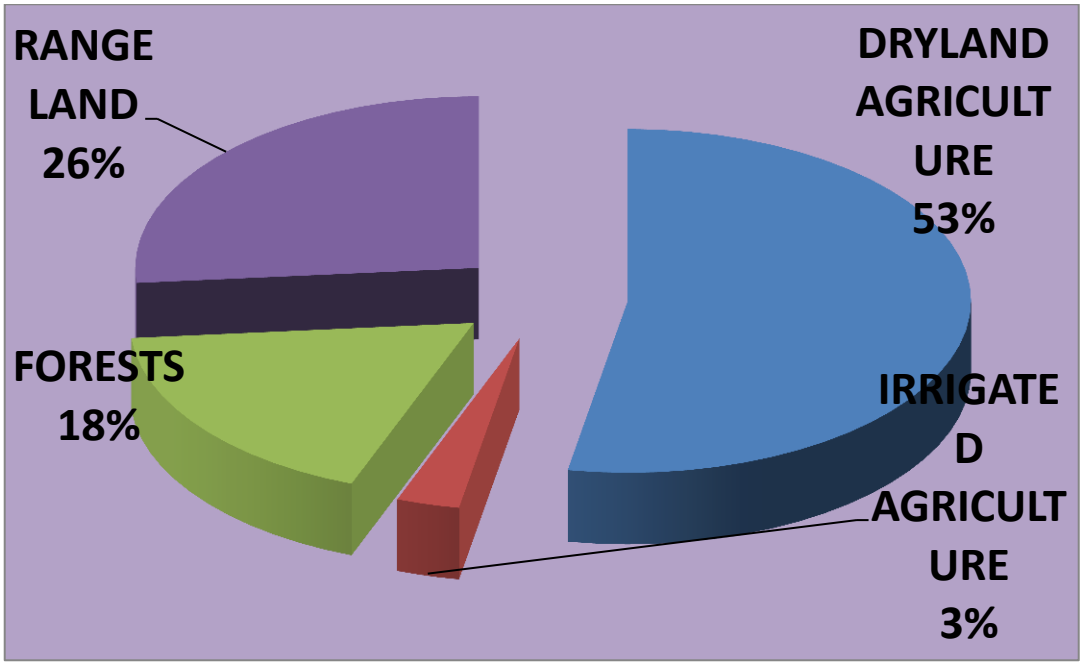
Source: (MOAF,Gedarif, Agriculture Guide 20١٢).

Sunflower:

Season	area thousand per acre	harvested area by thousand per acre	production by thousand tons	Productivity kg / tons.
٢٠٠٦	10	8	1.6	200
2007	55	55	9.6	175
2008	151	145	29	200
2009	33.1	28.8	3.4	120
2010	54.3	49	14.7	300
2011	88	78	13.5	173
2012	78.44	75.28	16.8	224

Source: (MOAF, Gedarif, Agriculture Guide 20١٢).

3.1.7 Figure: The uses of land in the state



Source: ((MOAF , Gedarif, Agriculture Guide 20١٢).

This part of literature review describes the models used in the analysis. The models of analysis include

3.2 Exponential trend Equation :

The methods used for estimating the growth rate and decomposition of growth components are described below:

$$Yt = AB^t \qquad (3.2.1)$$

Where :

Yt =area / production / productivity of crop concerned in the year t.

A= intercept

T=year

B= 1+r/100

Where, 'r' refers to the percentage rate of Compound Growth of area / production / productivity of crop per annum.

By taking logarithm of both sides of the equations, we get :

$$\text{Log } Yt = \text{Log } A + t \text{ Log } B \qquad (3.2.2)$$

If we put Log A = a, and Log B =b, then the above equation can be written as :

$$\text{Log } Yt = a + bt \qquad (3.2.3)$$

By using ordinary least square techniques, we have normal equation of the type

$$\sum \text{Log } Y = Na + b\sum t \qquad (3.2.4)$$

$$\sum (t \text{ Log } Y) = a \sum t + b \sum t^2 \qquad (3.2.5)$$

Where, N is the number of observations (years).

By solving equation (3.2.4) and (3.2.5) the value of ' a ' and 'b ' were computed.

When derivation are taken from middle year, i.e. $\sum t = 0$,the above equation takes the following form:

$$\sum \log Y = Na \qquad (3.2.6)$$

Then

$$a = \sum (\log y)/N \qquad (3.2.7)$$

and

$$\sum (\log Y) = bt^2 \qquad (3.2.8)$$

Then ,

$$b = \sum (t \log Y)/ \sum t^2$$

For deriving compound growth rate from the regression coefficient, the following procedures were adopted.

When time is measured in discrete intervals, such as quarter or years, a constant growth series would be expressed as

$$Yt = Y_0 (1+ r)t \qquad (3.2. 9)$$

Where, Y_0 = base year (value of year ($_0$) base year)

Yt = value of Y in year t.

r = compound growth rate

Taking logarithms of (3.1.9) to base 10 gives

$$\text{Log } Yt = Y_0 + (\log (1+r)t) \qquad (3.2.10)$$

This is the equation estimated with actual data.

Thus, Intercept = estimate of log Y_0

Slope = estimate of log (1+r)

And so an estimate of (r) can be obtained.

Comparison equation (3.1.10) with (3.1.3) shows that

Log B = log (1+r)

And r = antilog B – 1

Percentage rate of compound growth per annum was calculated as :

r = (antilog B -1) * 100 (G reen,2000)

which represent a rate of change from observation to observation during the period under study .

Moving period (10 year) compound growth rates in area, productivity and production of principal crops were also estimated for further analysis like regression estimates between growth and instability and for showing trends in area, production and productivity through graphs.

The production function is defined as the relationship between quantities of the various inputs used per unit time and the maximum quantity of the output produced at the particular time. Also, it can be defined as a relationship or mathematical relationship between an output (y) and different inputs (s) used to produce it.

Upton (1976) reported that the production function in theory, would include input such as disease that might influence yield. Production function can be represented by table(s),schedule (s),or mathematical equation (s) to determine the maximum output that can be produced from specified combinations of inputs at a given state of technology. The output that can be produced from specified combination of inputs at a given state of technology, the production function can be represented as follows:

$$Q_1 = f(X_1, X_2 \ldots\ldots\ldots\ldots X_n)$$

Where : Q_1 = output of the product

Xi – inputs used i =1 to n (Akram, 2008)

3.3 Regression analysis:

This is used to assess the relationship between the dependent variable and the independent variables that affect it. Regression may be simple or multiple.

3.4 Simple regression:

In the simple regression, the equation containing only one independent variable simple regression is seldom used in applied research because the working of most economic systems cannot be adequately represented by such simple formulation (Johnson, et al .1987).

Regression equation can be expressed mathematically as:-

$Y = B_o + B_o X$

Where: - Y= the dependent variable

B_o = intercept

B_o = regression coefficient

X = independent variable

3.9 Multiple regression:

Consider equation containing several independent variables. Multiple regression measures the change in one variable while holding the effect of other variables constant.

The general equation of multiple regression model is written as:

$$Y= b_o + b_1 X_1 + b_2 X_2 + b_n X_n$$

Where: Y = the dependent variable

$X_1 \ldots\ldots X_n$ = the independent variables

B_o = the intercept

The point where the linear equation intersects the Y axis,

B_1 …….B_n = the slope coefficient.

This says that unit change in the value of X results in ab1 unit change in y (Amira, 2008).

3.5 Cobb – Douglas production function:-

Cobb – Douglas production function has to be transformed to log- form by converting all variables measured, both input and output into their logarithms Johnson ,1987 . The advantages of the Cobb-Douglas function stated by Upton (1976) are:

1- Its easy to estimate so it can be extended to include more variables
2- Its resemblance to reality better than linear form.
3- Its theoretical fitness to agriculture.
4- Its easy to understand and easy to interpret.
5- The regression coefficients, immediately give the elasticity's of the product with respect to the factor of production that we get answer to the equation by how much percentage product would increase on average if the given factor increased by one percent.
6- It permits the phenomena of diminishing marginal returns without using any degree of freedom (Amira, 2008)

3.6 The coefficient of the multiple determinations R^2:

It gives the percentage of the variation in the dependent variable explained linearly by the variation in the independent variable. It could be low because of high variance of the disturbance term. However, high R^2 is not necessary for good estimates (Kennedy,1985).

3.7 Adjusted coefficient of determinations R^2:

One purpose of R^2 is to compare the explanatory power of different regression; however different regressions may involve different numbers of observations and different combinations of independent variables. Adjusted coefficient of determinations R^2 used to facilitate meaningful comparisons across equation using different explanatory variables and different sample sizes. The Adjusted R^2 is always lower than the adjusted R^2. It's possible to get a negative value for R^2 if the value of R^2 is low and degree of freedom is few (Johnson et al .1987).

3.8 Multicollinearity

Multicollinearity is a phenomenon that occurs in regression models when two or more independent variables tend to move together in the same direction. These variables are highly correlated and its difficult to separate their respective effects in the dependent variables (Kennedy, 1985).

Moreover, Multicollinearity is a sample problem and not a population problem. If there is correlation among the variables in the sample, it can happen that the coefficient of some variables will be significant in some formulations and not significant in others (Johnson et al .1987).

3.9 Measurement of instability in Production:

The purpose of this analysis was to study the fluctuations in output from its trend. Hence, annual percent changes in output and then the standard deviation in such annual changes were estimated which gave a measure of fluctuations around the trend line. Variability in annual output growth rates provide a measure of the degree of instability in production over the specified period.

3.10 Standard Deviation:

The standard deviation is defined as the square root of the mean of the squared deviation of individual values from their mean.

Symbolically,

$$\text{Standard deviation (S.D)} = \sqrt{\frac{\sum(X-\bar{X})^2}{N}}$$

$$\text{OR} \quad \sqrt{\frac{\sum(X)^2 - \sum(X)^2/n}{N}}$$

This is called standard deviation because of the fact that it indicates group standard spread of values around their mean.

The standard deviation is the most widely used measure of dispersion; it takes all the items into consideration. It more stable compared to other measures. However, it will be inflated by extreme items as is the mean.

3.11 Selection of Area:

Agriculture still contributes nearly 40% to the Gross Domestic product (GDP) and provides employment to more than 90% of workforce in the region under study .Gedarif is the most important farming units in the mechanized rain-fed sector of Sudan, for this reason they were selected for detailed investigation of agricultural growth and instability.

3.12 Sources of Data:

The study is based on secondary data time series data on area, production and productivity of sorghum & sesame obtained from the offices of the Agric-

Statistics Administration – Ministry of Agriculture, Forest & Irrigation, Gedarif state.

3.13 Period of study:

The present study covered the period 1979/80 to 1991/92 (pre-price liberalization period) and 1992/93 to 2011 /2012 ((post-price liberalization period) to analyze the effect of prices liberalization policy on growth, instability and rainfall of agriculture in Gedarif state.

The growth rate were estimated from the moving period of ten years length .A set of successive ten years was constituted from the entire series by excluding the first year of the previous and including the immediate next year from the series. The information generated through this analysis would serve as supplement to the growth analysis for the three corporation periods. Growth rate and fluctuation estimates for moving periods were also utilized to find out regression estimates between growth and instability.

The contribution of area, productivity and their interactions to the instability in production of concerned sorghum and sesame were estimated for the study period.

Regression analysis between growth rate and instability in sorghum and sesame were estimated through their moving estimates (1980/2012).It was done purposively to have an idea about the extent of relationship between growth, instability and rainfall of sorghum and sesame.

CHAPTER FOUR

Analysis of Agricultural Growth, Instability & Rainfall

4.1 Changes in Area, Productivity and Production

4.1.1 Chang in area:

An attempt has been made to study the cropping pattern with respect to proportion of sorghum & sesame in gross cropped area during the period under study. The changes that have taken place in respect of cropping pattern in area of study during the period under study (Pre-Liberalization Prices Policy and Post-Liberalization Prices Policy) are presented in Table (4.1.1).

The total area under sorghum crop increased from 2306.29 (000 fed) in the first period to 4793.77 (000 fed) in the second period registering an increased of 107.70 percent. Area under sesame increased from 352.08 (000 fed.) in the first period to 776.70 (000 fed.) in the second period registering an increase of 118.71 percent.

On the basis of the above discussion, it may be concluded that, changes in areas of sorghum and sesame responded positively during prices liberalization policy period and this was mainly due to prices liberalization.

Table 4- 1: The change in cropping pattern:

	Period1(Pre_ liberalization.)	Period II (Post-liberalization)	
CROPS	(000)/Fed	(000)/Fed	Change %
Sesame	352.38	776.70	118.71
Sorghum	2306.29	4793.77	107.70

Source: computed from data obtained from MOAF, Gedarif (1970-2012)

4.1.2 Changes in productivity

Productivity of sesame increased at the second period by 11.25% but sorghum productivity declined by -31.02%.

Table 4- 2: Chang in productivity

	Period1 (Pre_ liberalization.)	Period II (Post-liberalization)	
CROPS	(000)/Fed	(000)/Fed	Change %
Sesame	0.263	0.181	-31.02
Sorghum	0.123	0.136	11.25

Source: computed from data obtained from MOAF, Gedarif (1970-2012)

4.1.3 Changes in production

Production of sesame increased during the second period by 53.73% and sorghum production increased by 14.1%.

This means that there an increase in Sorghum and Sesame production during prices liberalization policy period.

Table 4- 3: Chang in production:

	Period1 (Pre_ liberalization.)	Period II (Post-liberalization)	
CROPS	(000)/Fed	(000)/Fed	Change %
Sorghum	603.71	688.71	14.1
Sesame	43,952.38	67,568.18	53.73

Source: computed from data obtained from MOAF, Gedarif (1970-2012)

4.2 Growth rate in Area

An attempt has been made to analyze the compound annual growth rate in area, production and productivity of sesame and sorghum crops during the specified periods i.e., study period (1971-70 to 2011/12)period I (pre-prices liberalization policy- i.e., 1971- 70 to 1991/92) and period II(post- prices liberalization policy- i.e., 1992/93 to2012/13.

It may be observed from the table below that, area under sorghum recoded annual growth rate of (3.3) percent during the study period, however ,higher growth in area was observed in period I which was (4.60%) , and it showed a decline in period II which was (0.883%) percent. Area growth rate of sesame was (2.6%) during the study period, but it decreased to (0.90%) in period I and also in period II (0.94%).

Table 4- 4: Growth rate in Area:

	Period1(Pre_ liberalization.)	Period II (Post-liberalization)	
Sesame	0.90	0.94	2.6
Sorghum	4.60	0.883	3.3

Source: computed from data obtained from MOAF, Gedarif (1970-2012)

4.3 Growth rate in productivity:

Annual growth rate in sorghum productivity was negative during the period under study (-1.89%), however, the growth rate in sorghum productivity during sub-period recorded was -3.00% in period I (pre price liberalization police),and it decreased to -2.42 in period I1.

The productivity growth rate of sesame was -1.59% during the period under study , however the growth in productivity during sup periods showed a increasing trend, i.e., -1.32% , and 0.07% during period I and period II, respectively.

Table 4- 5: Growth in productivity

	Period1(Pre_ liberalization.)	Period II (Post-liberalization)	
Sorghum	-3.00	-2.42	-1.89
Sesame	-1.32	0.07	-1.59

Source: computed from data obtained from MOAF, Gedarif (1970-2012)

4.4 Growth in production:

Sorghum: - The annual growth rate of sorghum is estimated at 1.20 percent during the study period (Table below).Sup-period–wise analysis that the production growth rate decreased from 0.82 percent in period I, to -2.70 percent in period II.

Sesame :- Annual growth rate of sesame showed positive trend in the study period, it was 0.21% , however, the growth rate in sesame production was negative during period I(-1.35%), and, increased to 0.19 in period 11.

Table 4- 6: Growth in production

	Period1(Pre_ liberalization.)	Period II (Post-liberalization)	
Sorghum	0.82	-2.70	1.20
Sesame	-1.35	0.19	0.21

Source: computed from data obtained from MOAF, Gedarif (1970-2012)

4.5. Analysis of agricultural instability:

In the present section, an attempt has been made to study the fluctuations in output from its trend. Hence, annual percent changes in output and then the standard deviation (SD) in such annual changes were estimated which gave a measure of fluctuations around the trend line.

4.5.1 Instability in Area and productivity:

Instability in production of sorghum and sesame is expected to be caused by instability in area and production. If the instability in both components declined, the instability in production has to decline during particular period of time. To test this hypothesis standard deviations (SD) of area and productivity of sorghum and sesame were computed and presented in tables below. It is interesting to observe that instability in area and productivity in some of crops fluctuated in the same direction, i.e., if there an increase/decrease in instability in the area of aparticular crop, the instability in productivity also increases/decreases .It has been observed that instability in area and productivity increased during period II in sesame, and decreased during period II in sorghum.

As discussed earlier, the instability in area and productivity generally move in same direction, but area instability is generally lower than the productivity instability for the two crops.

Table 4- 7: Instability in area and production in sesame:

	Period1(Pre_ liberalization.)		Period II (Post-liberalization)	Study period
Sesame	33.00	A	53.86	44.02
	49.21	Y	192.44	140.17

Source: computed from data obtained from MOAF, Gedarif (1970-2012)

Table 4- 8: Instability in area and productivity of sorghum:

	Period1		**Period II**
Sorghum	18.22	A	13.97
	83.41	Y	51.95

Source: computed from data obtained from MOAF, Gedarif (1970-2012)

4.5.2 Measurement of instability in production:

The perusal of table below indicated that the standard deviation (SD) of sorghum production was estimated to 115.88% in the first period and decreased to 105.01% in the second period. Instability of sesame production was estimated to 46.52 % in the first period and increased to 101.81% in the second period.

Table 4- 9: Instability in production:

	Period I (percent)	Period II (percent)
Sorghum	115.88	105.01
Sesame	46.52	101.81

Source: computed from data obtained from MOAF, Gedarif (1970-2012))

4.5.3 Analysis of relationship between moving growth and instability:

In what follows we shall concentrate mainly on the analysis of the growth – instability relationship in respect to crop production, the relationship between growth rate and instability in major principal crops grown in the project area has been examined. The growth rate and instability (SD) of sorghum & sesame are presented in Table (4.5.4).

Table 4- 10: Relationship between growth and instability

Crop		Period I	Period II
Sorghum	growth	0.82	-2.7
	SD	115.88	105.01
Sesame	growth	-1.35	0.19
	SD	46.52	101.81

Source: computed from data obtained from MOAF, Gedarif (1970-2012)

There was a decrease in growth rate of sorghum production from 0.82% during period I to -2.7% in period II, the respective instability in sorghum production decreased from 115.88% to 105.01%. Growth rate in sesame production increased from -1.35% in period I to 0.91% in period II, but instability increased from 46.52 percent during period I to 101.81 percent in period II.

Regression estimates between moving growth rate and instability (SD), were estimated for all crops. It was estimated for the two periods, i.e., pre-prices liberalization policy (1970/71 to 1991/92) and post-prices liberalization policy (1992/93 to 20011/20012). The regression estimates are presented in Table (4.11).

4.5.4 Regression analysis between growth and instability:

Some of the study on the relationship between growth and instability have emphasized that growth and instability are positively associated (Hazell,1982). In present study, we examine this hypothesis by looking by looking at the association between growth rates and instabilities during period I and period II. Relationship between growth (dependent variable) and instability (independent variable) for sorghum was found positive during period I and period II, which means that an increase in instability would affect growth positively. In sesame,

the relationship was negative in period I and turned to be positive in period II and study period.

Table 4- 11: Regression analysis between growth and instability

	Period1	**Period II**
Sorghum	0.00091	0.017
Sesame	-0.153	0.091

Source: computed from data obtained from MOAF, Gedarif (1970-2012)

4.5.5Relationship between rainfall and instability of crop production:

It is well known that weather, particularly rainfall, plays an important role in agriculture in Sudan. In the present study, we examine the effect of rainfall in instability of crop production by studying the relationship between rainfall as independent variable and instability as dependent variable during the study period. The result of the analysis shows that the relationship is negative in sorghum and sesame, which means that an increase in rainfall would decrease the instability of crop production table (4.12).

Table 4- 12 : Relationship between rainfall and instability

crop		**B**
Sorghum	constant	90.74
	rainfall	-0.007
Sesame	constant	50.17
	rainfall	-0.05

Source: computed from data obtained from MOAF, Gedarif (1970-2012)

CHAPTER FIVE

5.1 Summary, conclusions and recommendation

The productivity of the agricultural crops in Sudan are low and instable. caused by differences in climate, level of infrastructural facilities and socio-economic characteristics of different regions of the country. So, the instability in farm output has also been an important aspect of agricultural growth. The fluctuation in agricultural production for interdependent to processes in the economy. There has been a dearth on studies dealing with growth and instability in agriculture in Sudan. Hence, the present study was undertaken to analyze weather, growth and instability in agricultural production pre and post price liberalization policy.

The study focused on mechanize rain-fed in Gedarif and covered the pre- price liberalization policy period, i.e.(1971/ 70- 1991/92) and the post-price liberalization policy period (1992/93 -2011/12). Analysis was based on secondary data on area, production and productivity of sorghum and sesame and rainfall.

Were used for the analyses of the data Statistical Package for Social Science (SPSS) and (Excel).

Analysis of data on area under sorghum & sesame showed increasing trend during post price liberalization policy period.

The analysis of compound annual growth rate in area showed a positive growth rate in sorghum and sesame during post –liberalization period. Production of sesame and sorghum showed positive trend during the second period.

The analysis of compound annual growth in area showed appositive growth rate in sorghum and sesame in post –liberalization period.

Annual compound growth rate of sorghum production showed declined growth rate and negative trend during post-price liberalization period

On the basis of the above discussion, the increase in production of sorghum was mainly due to the cultivation of high yield varieties. The decline in sorghum growth rate production was due to the government policies .The applied policies were taxing the crop at fluctuating high rates , the input subsides were far below taxation rates

The study of instability indicated that sorghum and sesame witnessed continuous increase in instability over the two sub-periods under study, and the instability in sorghum production witnessed a decrease during post-liberalization period. It is also worth pointing out that the instability in area and productivity of almost all crops move in the same direction and their increasing/decreasing trend resulted in increasing/decreasing in instability.

Hence, it may be said that the increase in production of a particular crop due to a spectacular increase in area and productivity would accompany the increase in instability also, but an increase in production largely due to the increase in productivity would help declining production instability.

An effort was also made to study the relationship between production growth and instability of sorghum and sesame It was found that sesame and sorghum had positive relationship in Gedarif during the study period.

The above findings clearly indicated that the increase in production mainly due to an increase in productivity had positive relationship but the increase in production due to the increase in area and productivity had negative relationship between growth and instability in production of particular crop. Hence, it may be said that the stability in agricultural production may be achieved by increasing productivity without a decline in area in a particular crop. It could also be

achieved by making investment in agricultural research and keeping favorable agricultural price policy.

5.2 Recommendation:

The results of the study showed the following measures could be taken as recommendations to help reducing the fluctuations on crop production, although crop production growth and instability is affected by factors others than pricing policies, these include socio-economic, political and technical factors. So, the scope of research is narrow. Some recommendations are as follows:

1. Stability can be achieved if the environment for the crop production is under human control.
2. Reducing production instability by using drought tolerant varieties and improved seeds
3. To formulate and adopt around prices policy aiming to revise the tax system so as the remove their heavy burden on production.
4. To rehabilitate the infrastructure of mechanized rain-fed sector in Gedarif.
5. The stability in a production may be achieved by increasing productivity without a decline in area in particular crop. It could only be achieved by making investment in agricultural research and keeping favorable agricultural prices.

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Appendices

ملحق (١) يوضح المساحات المزروعة والمحصودة بالفدان والإنتاجية كجم /فدان والإنتاج .بالإلف طن لمحصول الذرة لسلسلة زمنية(١٩٧٠-٢٠٠٧م)

الموسم	المساحة بالإلف /فدان	المساحة المحصودة بالإلف /فدان	الإنتاج بالإلف طن	الإنتاجية كجم /فدان
١٩٧١-٧٠	١٧٤٢	-	٤٥٣	٢٦٠
١٩٧٢-٧١	١٤٦٨	-	٤٥٢	٣٠٨
١٩٧٣-٧٢	١٠٨٣	-	٢٠٨	١٩٢
١٩٧٤ -٧٣	١٣٩١	-	٤٤٧	٣٢١
١٩٧٥ -٧٤	١٦٣٥	-	٦٥١	٣٤٣
١٩٧٦ – ٧٥	٢٠٠٠	-	٧٠٦	٣٥٢
١٩٧٧- ٧٦	١٩١٠	-	٥٢٢	٢٧٣
١٩٧٨ -٧٧	١٨٤٨	-	٥٥٤	٣٠٠
١٩٧٩ -٧٨	٢٠٤٣	-	٥١٦	٢٥٣
١٩٨٠ -٧٩	١٦٧٢	-	٤٦٧	٢٧٩
١٩٨١-٨٠	٢١٩١	-	٧٧٥	٣٥٤
١٩٨٢ -٨١	٢٦٥٨	-	١١٨٣	٤٠٠
١٩٨٣ -٨٢	٢٨٨٠	-	٦٧١	١٧٣
١٩٨٤ -٨٣	٢٩٤٧	-	٥٧٨	١٩٦
١٩٨٥ - ٨٥	٢٥٠٢	-	١٩٥	٧٨
١٩٨٦ – ٨٥	٣٤٠٠	-	١٠٢٠	٣٠٠
١٩٨٧ -٨٦	٣٣٠٠	-	١٠٢٠	٣٠٩
١٩٨٨ -٨٧	٢٦٣٥	-	٣٩٥	١٥٠
١٩٨٩ -٨٨	٢٩٥٧	-	١٢٤٢	٤٢٠
١٩٩٠ - ٨٩	٢٩٠٠	-	٤٤٠	١٥٢
١٩٩١-٩٠	٣٢٧٠	١٨٢٦	١٨٣	١٠٠
١٩٩٢-٩١	٥٧٨٣	٢٨٩٠	١١٢٤	٢٨٩
١٩٩٣-٩٣	٤٦٦٧	٣٧٣٥	١١٧٣	٣١٤
١٩٩٤ -٩٣	٤٥٠٠	٣٦٠٠	٧٦٧	٢١٣
١٩٩٥ -٩٤	٤٥٣٠	٤٢٥٩	٩١٦	٢١٥
١٩٩٦ -٩٥	٤١٨٠	٣٤٣٠	٥٥٦	١٦٢
١٩٩٧ -٩٦	٥٤٢٧	٥٢٩٧	١١٤٥	٢١٦
١٩٩٨ -٩٧	٤٢٤٨	٣٢٨٠	٤٩٤	١٥١
١٩٩٩ -٩٨	٤٦٦١	٤٥٠١	١٢١٥	٢٧٠
٢٠٠٠ -٩٩	٣٩١٠	٢٨٦٩	٣١٥	١١٠
٢٠٠١ -٢٠٠٠	٣٥٠٠	٢٦٢٥	٤٩٥	١٨٨
٢٠٠٢ -٢٠٠١	٤٣٨٢	٢٨٣٤	٣٦٨	١٣٠
٢٠٠٣ -٢٠٠٢	٤٣٨٢	٢٨٣٤	٣٦٨	١٣٠
٢٠٠٤ – ٢٠٠٣	٤٢٠٣	٢٨٨٥	٤٧٣	١٦٤
٢٠٠٥ -٢٠٠٤	٤٨٧٠	٤١٨٧	٨٥٢	٢٠٣
٢٠٠٦-٢٠٠٥م	٤٥٦٧	٢٩٩٥	٤١٤	٩٠.٦
٢٠٠٧-٢٠٠٦م	٤٦١٩	٣٠٣٠	٥٢١	١٦٨.٣
2008-2007	4374	3220	572,2	117,8
2009-2008	5260	3416	416	180
2010-2009	5871	2033	187	92
2011-2010	6018	4514	812	180
2012-2011	5530	2905	392	134
2013-2012	5981	5191	1380	266

ملحق (2) يوضح المساحات المزروعة والمحصودة بالفدان والإنتاجية كجم /فدان والإنتاج بالآلف طن لمحصول السمسم .

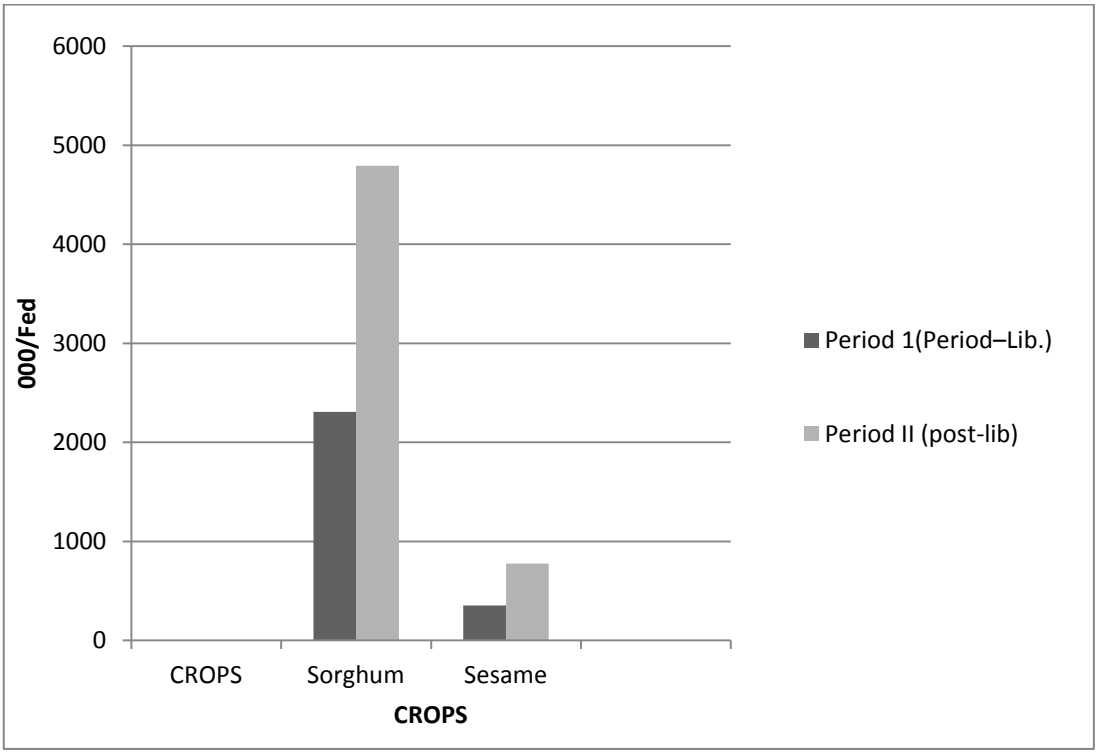
الموسم	المساحة بالإلف /فدان	المساحة المحصودة بالإلف /فدان	الإنتاج بالإلف طن	الإنتاجية كجم /طن
١٩٧١-٧٠	٢٨٥	-	٤٢	١٤٩
١٩٧٢-٧١	٢٧٨	-	٣٩	١٣٩
١٩٧٣-٧٢	٣٧٠	-	٦٠	١٦٣
١٩٧٤ -٧٣	٤٤٢	-	٧٨	١٧٦
١٩٧٥ -٧٤	٣٧٤	-	٣٣	٨٦
١٩٧٦ ــ ٧٥	٣٧٤	-	٣٤	٩٧
١٩٧٧- ٧٦	٤٠٠	-	٥٩	٤٧
١٩٧٨ -٧٧	٣٤٤	-	٤٦	١٣٤
١٩٧٩ -٧٨	١٩٤	-	٢٦	١٣٤
١٩٨٠ -٧٩	٣٤١	-	٥٤	١٥٨
١٩٨١-٨٠	٣١٧	-	٤٨	١٥١
١٩٨٢ -٨١	٢٥٣	-	٤٠	١٥٨
١٩٨٣ -٨٢	٢١٨	-	٢٧	١٢٤
١٩٨٤ -٨٣	٤٢٧	-	٤٧	١١٠
١٩٨٥- ٨٥	٣٤٣	-	٣٩	١١٤
١٩٨٦ ــ ٨٥	٤٣٠	-	٣٧	٨٥
١٩٨٧ -٨٦	٤٧٠	-	٦٦	١٤٠
١٩٨٨ -٨٧	٤٥٠	-	٥٥	١٢٥
١٩٨٩ -٨٨	٣٤٠	-	٣٤	١٠٠
١٩٩٠- ٨٩	٣٥٠	-	٣٢	٩٠
١٩٩١-٩٠	٤٠٠	٣٠٠	٢٧	٩٠
١٩٩٢-٩١	٤٠٠	٣٥٠	٣١	٩٠
١٩٩٣-٩٣	٨٩٣	٧١٥	٧٩	١١٠
١٩٩٤ -٩٣	٥٠٠	٤٩٠	٣٩	٧٠
١٩٩٥ -٩٤	٧١٥	٦٢٧	٥٦	٩٠
١٩٩٦ -٩٥	١٢٥٠	١٠٦٥	١١٩	١١٢
١٩٩٧ -٩٦	١١٠٠	٩٢٥	١٠٨	١١٧
١٩٩٨ -٩٧	٨٦٧	٨٥٢	٨٦	١٠١
١٩٩٩ -٩٨	٧٢١	٦٢٤	٤٧	٧٥
٢٠٠٠ -٩٩	١٢٩٥	١١١٩	٨٧	٧٠
٢٠٠١ -٢٠٠٠	١٠٥٠	٩٦٦	٧٥	٧٨
٢٠٠٢ -٢٠٠١	٧٣٧	٦٥٨	٤٦	٧٠
٢٠٠٣ -٢٠٠٢	٤٣١	٣٣٠	٢٧	٨١
٢٠٠٤ ــ ٢٠٠٣	١٠١٠	٩١٦	١١٤	١٢٥
٢٠٠٥ -٢٠٠٤	٨٩٢	-	٦٠.٢	٦٧.٥
٢٠٠٦-٢٠٠٥	٧٤٩.٥		٦٤.٥	٧٢.٣
٢٠٠٧-٢٠٠٦	٦١٢	٥٤٣	٤٧	٨٦.٦
2008-2007	576	475	37	78
2009-2008	474	457	62	132
2010-2009	697	487	64	92
2011-2010	637	568	73	128.8
2012-2011	484	366	36.8	100.3
2013-2012	829	757	128	169

ملحق (٣) معدل المطر السنوي بمحطات الزراعة الآلية من عام ١٩٨٠ ـــــــــــــ ٢٠٠٧م

الموسم	القضارف	القد مبلية	ام سينات	دوكة	سمسم	الحواتة
١٩٨٠	٦٣٨	٥٨٠	٥٩٥	٦٠٣	٦٦٨	٢٢٢
١٩٨١	٦٢٤	٤٧٥	٦٦٩	٤٨٧	٨١٦	٥١٠
١٩٨٢	٧١٥	٣٤٠	٦٤٧	٥٥٠	٧٥٦	٣٥٧
١٩٨٣	٤٨١	٣٩٠	٥٣٧	٧١٧	٦٣٤	٣٩٢
١٩٨٤	٣٢٢	٢٨٥	٥٤٤	٥٩٣	٦٦٠	٤٢٣
١٩٨٥	٧٢٥	٤٦٢	٦١٥	٦٧٥	٧٨١	٥٦٩
١٩٨٦	٦٠٤	٥٩٨	٤٥٧	٥٨٤	٦٠٣	٤٤٣
١٩٨٧	٤٧٥	٤٣٦	٦٦٠	٦٣٦	٧٠٢	٤٦١
١٩٨٨	٥٨٤	٦٥١	٧٧٢	٨٤١	٧٣٥	٦٠٠
١٩٨٩	٧٥٨	٦٤٤	٩٤٨	٦٤٠	٨١٠	٥٧٦
١٩٩٠	٣٧١	٣٦٩	٥٤٥	٦٤١	٥٥٩	٢٨٣
١٩٩١	٣٩٥	٤٦٢	٥٠٠	٥٣٦	٥١٣	٥٩٠
١٩٩٢	٥٧٤	٧٣٠	٨٠١	٧٤٦	٨٢٩	٤٥٥
١٩٩٣	٧٥٥	٦١٦	٨١٨	٦٠٠	٧٧٤	٦٠٠
١٩٩٤	٦٣١	٦١٩	١٠٧٠	٦٩٦	٨٢٦	٤٧٨
١٩٩٥	٥٢٦	٤٦٣	٦٩٤	٦٤٥	٧٩٢	٦٥٦
١٩٩٦	٧١٣	٦٢٧	٦٠٢	٥٦٦	٨٢١	٧٠٠
١٩٩٧	٥٢٨	٤٥٢	٧١٥	٦٧٨	٧٨٨	٦٤٥
١٩٩٨	٥٧٠	٥٨٢	٨١٢	٧٤٢	٦٠٢	٨٠٩
١٩٩٩	٨٧١	٥٣١	٧٢٤	٨٠٠	٨٥٤	٧٨٩
٢٠٠٠	٦٣٧	٤٢٦	٦٢٧	٦٧٨	٤٢٠	٧٢٧
٢٠٠١	٤٧٦	٤٩٠	٧٢١	٥٧٨	٧٥٧	٥٣٦
٢٠٠٢	٦٣١	٤٨٣	٦٨٧	٦٣٨	٥١٦	٤٩٢
٢٠٠٣	٨٢٥	٦٠٧	٦٤٢	٧١١	٥٨٤	٦١٦
٢٠٠٤	٥٣٥	٤٢٦	٤٨٨	٤٦٤	٨١١	٣٨٧
٢٠٠٥	٥٥١.٤	٦١٠	٦٥٦	٦٨٢	٨٩٦	٤٠٢
٢٠٠٦	٦٧٢	٥٣١	٤٣٣.٥	٥٨٦	٧٤٦	٤٥٤
٢٠٠٧	٤٩٣.١	٤٥٤.٣	٧١٨.٥	٦٨٥.٦	٦٤٩.٨	٦١٧.٨
٢٠٠٨	٦٠٨.١	٤٥٣.٥	٨٥٨.٩٨	٩٦١.٣	٦٨٦	٥١٥.٥
٢٠٠٩	٥٤٢.٦	٣٨٤	٤٧٦.٤	٦٤٨	٥٥٧.١	٢٨٥.٣
٢٠١٠	٦٥١	٥١٢	٩٢٨	٧٧٢	٦٠٦	٤٥٤
٢٠١١	٥٠٥	٤٦٤	٥٠٢.٦	٧٦٢.٦	٤٢٥	٤٣٧.٤
٢٠١٢	٥٩٦	٧٥١.٦	٦٢٠.٤	٩٠٦.٨	١٠٢٣.٥	٨٣٧.٩

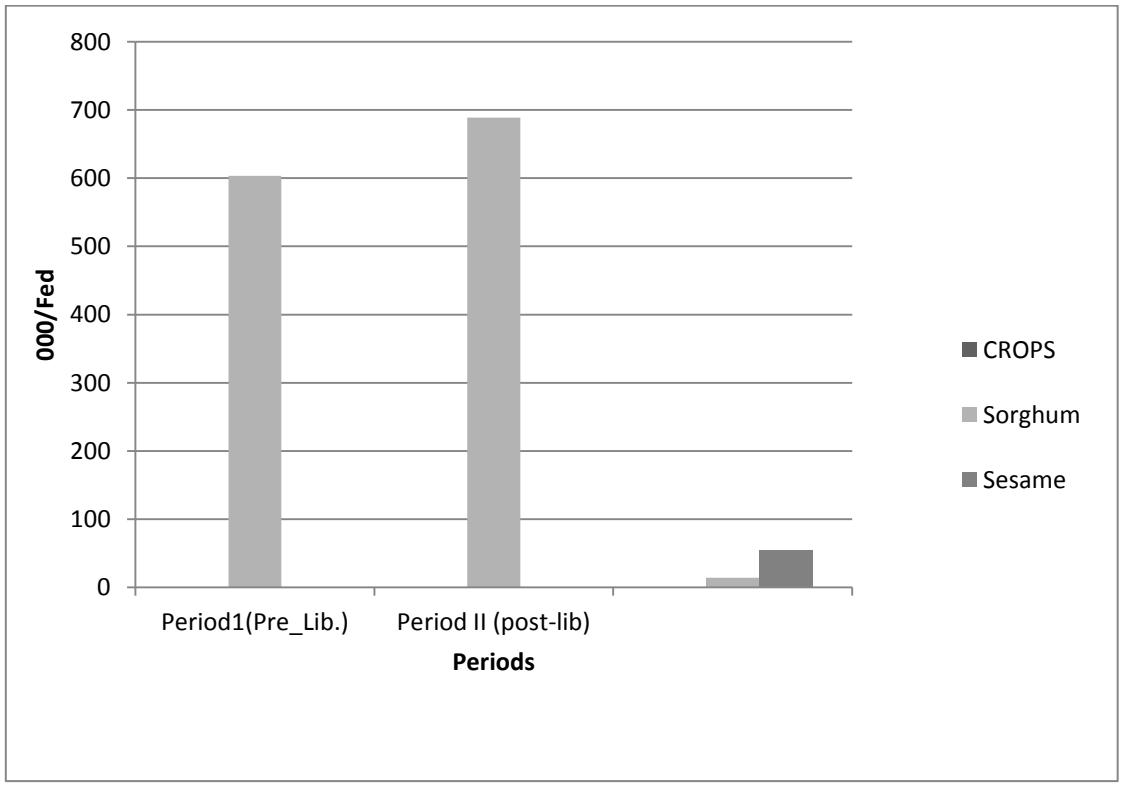
.

Appendix (1)



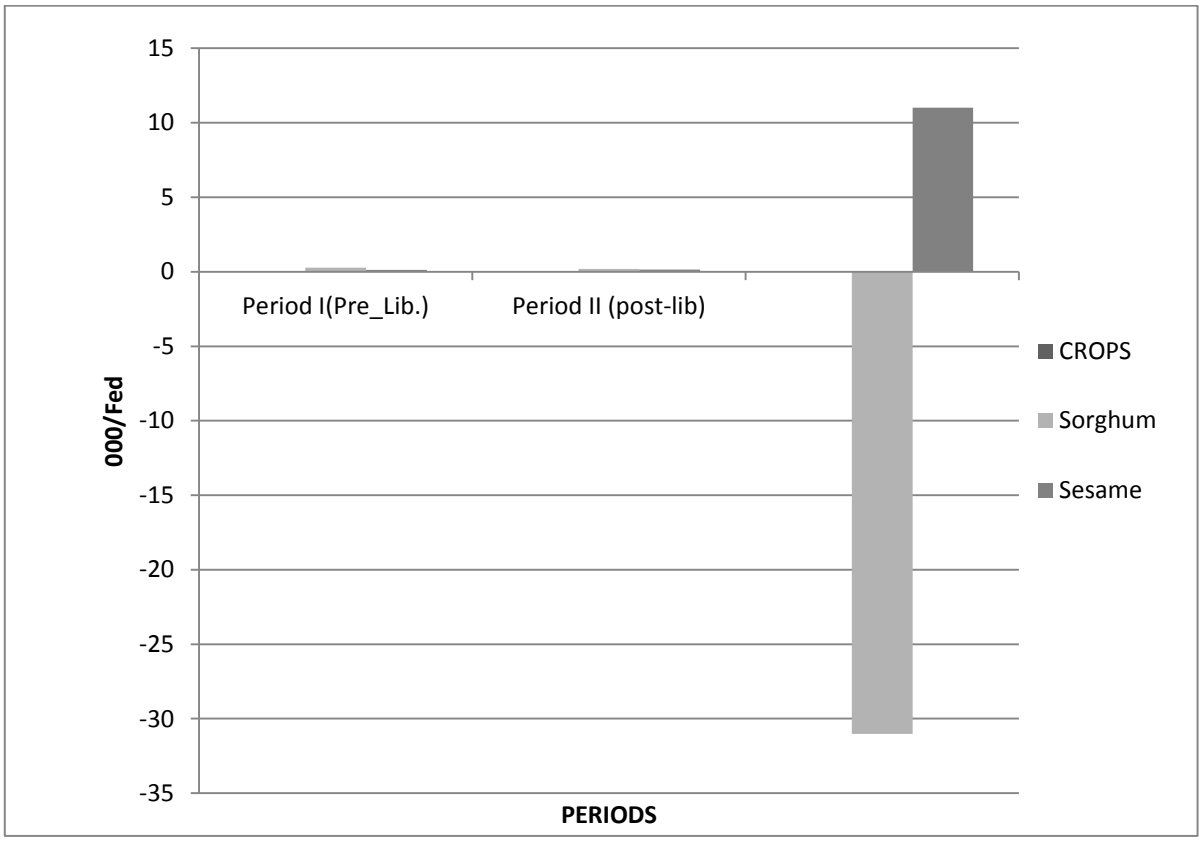
The Changes in Cropping pattern

Appendix (2)



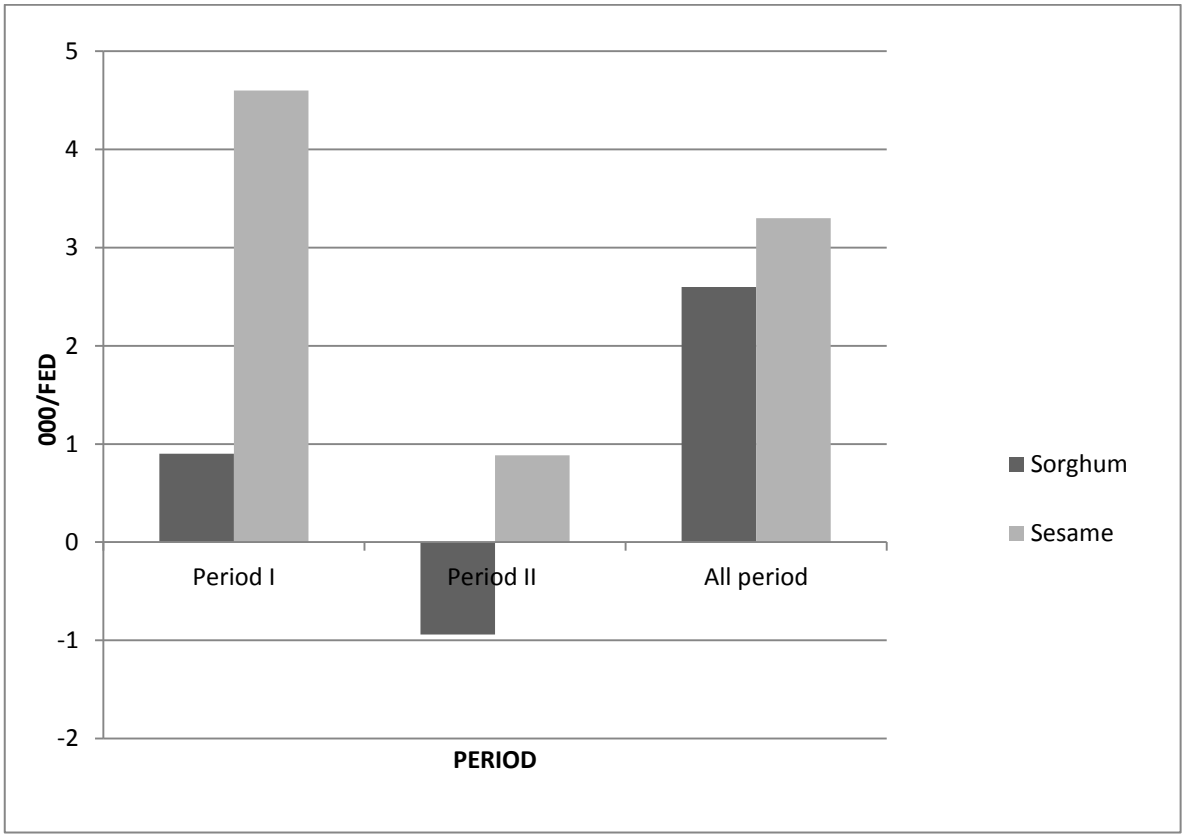
Chang in production

Appendix (3)



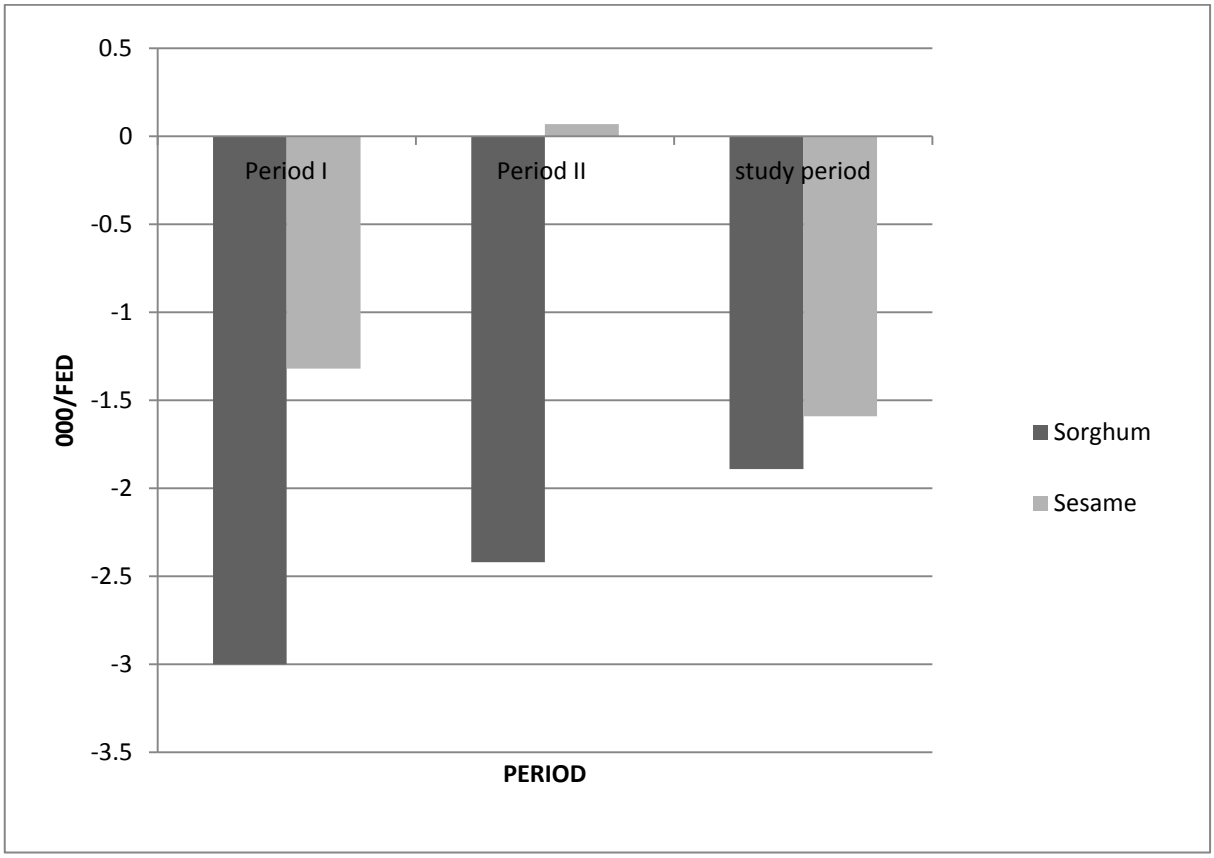
Chang in productivity

Appendix (4)



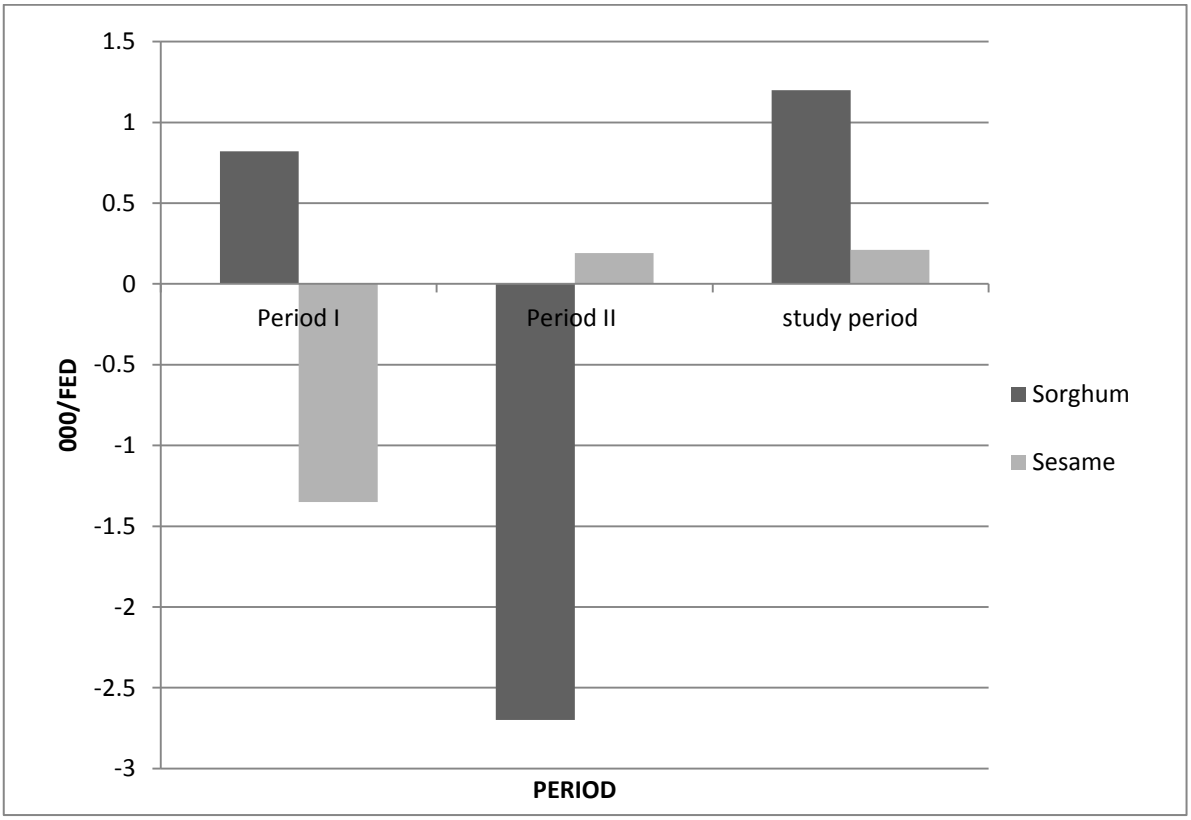
Growth in Area

Appendix (5)



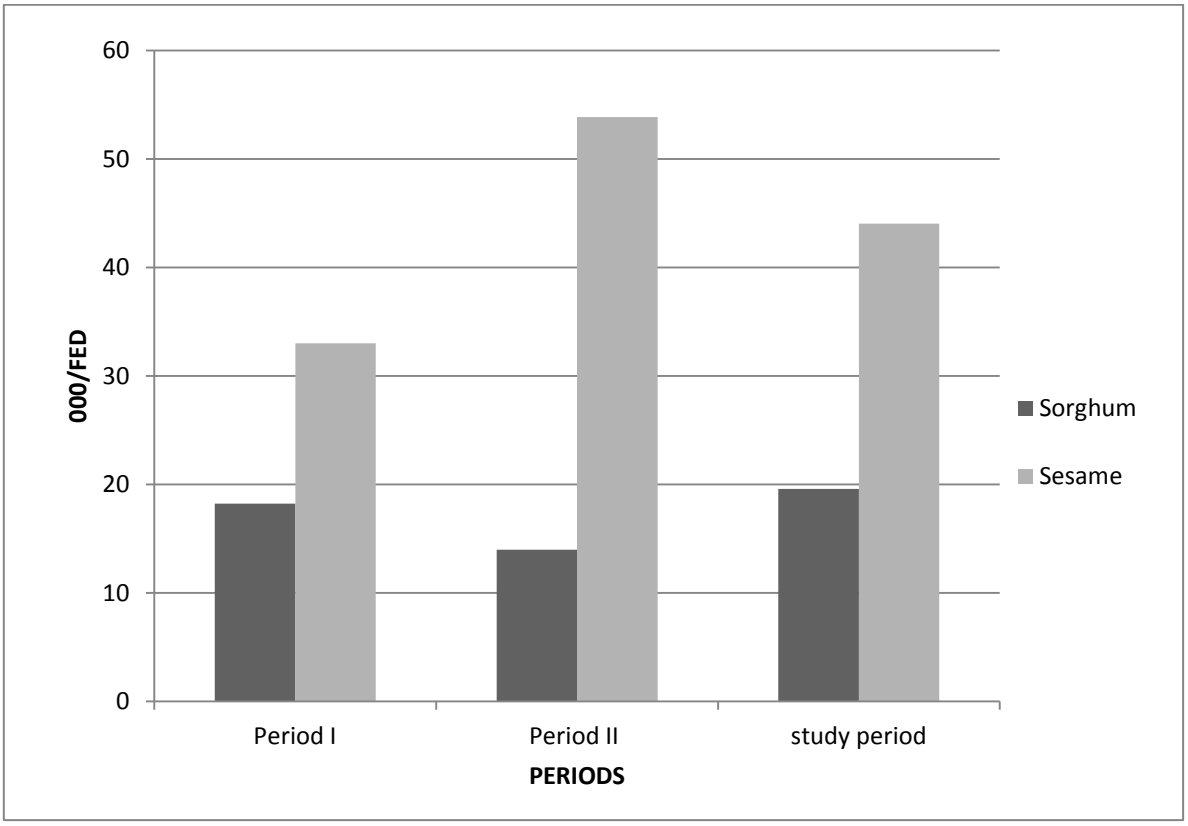
Growth in productivity

Appendix (6)



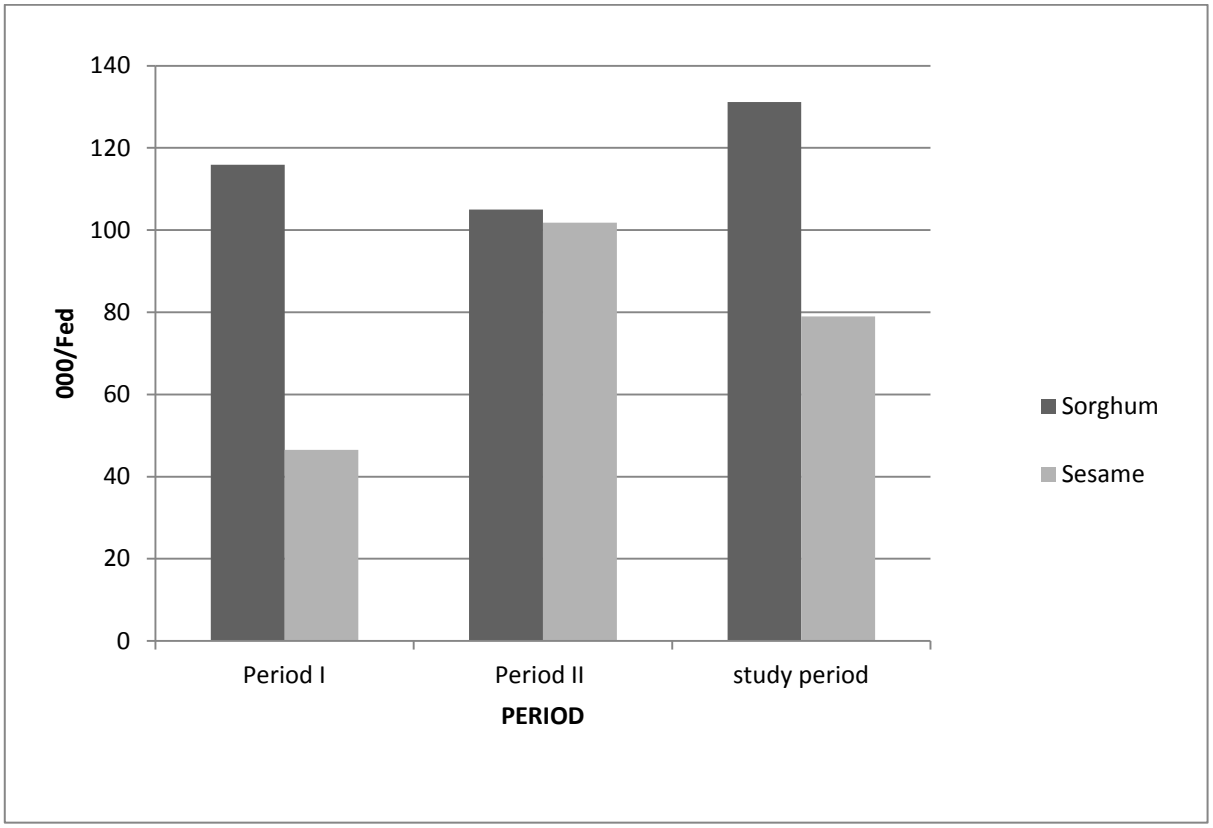
Growth in production

Appendix (7)



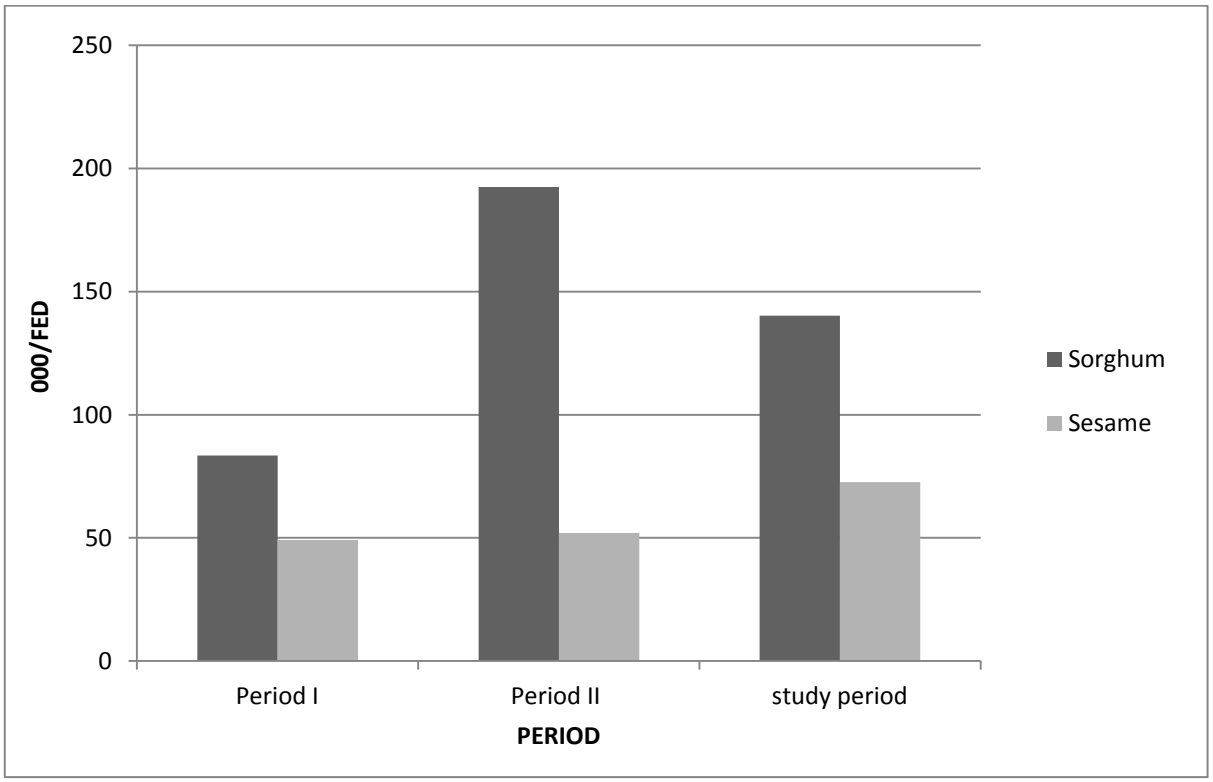
Instability in area

Appendix (8)



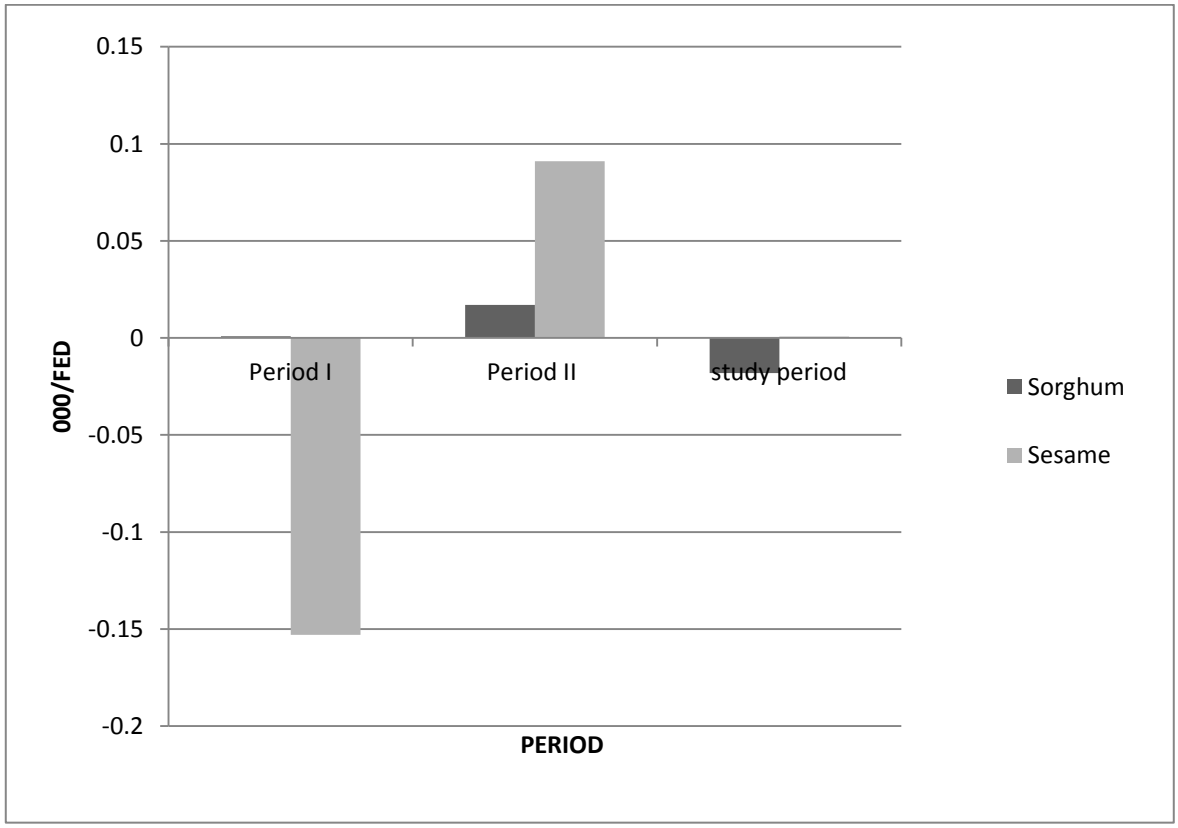
Instability in crop production

Appendix (9)



Instability in productivity

Appendix (10)



Analysis of relationship between moving growth and instability