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Trends and Changes in Sesame Production
in the Sudan , 1961/62 to 1982/83

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Trends and Changes in Sesame Production
in the Sudan: 1961/62 - 1982/83

I Introduction

Sesame is an important oilseed crop in the Sudan which is grown entirely under rainfed conditions . It is also an important export crop . On an average for the 4 years 1980 to 1983 Sudan exported 61111 MT of sesame, 1344 MT of sesame oil and earned LS 37.6 million per year which is slightly more than the export earnings from groundnuts . However, the relative importance of sesame among the 5 main food crops¹ of Sudan has been declining . As shown in Table 1, on an average for the 11-year period 1961/62 to 1971/72, sesame occupied 16.6 percent of the total area planted to the 5 crops and contributed 8.8 percent to their production . These shares for the 11-year period 1972/73 to 1982/83 dropped to 15.6 percent and 6.7 percent, respectively, and further declined to 13.5 percent and 5.9 percent for the more recent 5-year period 1979/80 to 1983/84 (Table 2) .

At the same time average yearly area planted to sesame increased approximately 77 percent from 1239000 FD during the first 11-year period to 2201000 FD during the second 11-year period (Table 3) . For the 22-year period 1961/62 to 1982/83 areas planted to sesame continued to increase at an average annual compound rate of growth (computed from log-

1. Sorghum, Wheat, Millet, Sesame and Groundnuts .

Table 1 . Shares of Individual Food Crops in Total Area and Production of Food Crops, in the Sudan Averages of 1961/62 to 1971/72 and 1972/73 to 1982/83.

Crop	Production		Area	
	1961/62 to 1971/72	1972/73 to 1982/83	1961/62 to 1971/72	1972/73 to 1982/83
	(Percent)			
Sorghum	59.7	55.8	50.0	46.9
Wheat	3.7	6.2	2.4	3.3
Millet	14.9	11.8	19.1	19.3
Sesame	8.8	6.7	16.6	15.6
Groundnuts	12.9	19.5	11.9	14.9

Table 2

5-Year Average Production and Area of Food Crops, 1979/80 to 1983/84, Sudan

	Production (000 MT)	Area (000 FD)
Sorghum	2118 (59.4) (78.7)	7863 (52.1) (71.8)
Millet	392 (11.0) (14.6)	2730 (18.1) (24.9)
Wheat	180 (5.1) (6.7)	360 (2.4) (3.3)
Total-cereals	2690 (75.5) (100)	10953 (72.5) (100)
Sesame	211 (5.9) (24.1)	2040 (13.5) (49.1)
Groundnuts	663 (18.6) (75.9)	2111 (14.0) (50.9)
Total-oilseeds	874 (24.5) (100)	4151 (27.5) (100)
Total-foodcrops	3564 (100) -	15104 (100) -

Note : Figures in the parentheses are percentages .

Table 3 . Average Production, Area and Yield of Sesame, 1961/62-1971/72 and 1972/73-1982/83, Sudan

Sector	1961/62- 1971/72	1972/73- 1982/83	Change	Change (%)
	<u>Average production (000 MT)</u>			
All Sudan	195(100)	237(100)	42(100)	21.5
Mecharized	35(18)	71(30)	36(86)	102.9
Traditional	160(82)	166(70)	6(14)	3.8
	<u>Average area (000 Feddans)</u>			
All Sudan	1,239(100)	2201(100)	962(100)	77.6
Mechanized	226(18)	556(25)	330(34)	146.0
Traditional	1,013(82)	1645(75)	632(66)	62.4
	<u>Average yield (Kgs/FD)</u>			
All Sudan	157	108	-49	-31.2
Mechanized	155	128	-27	-17.4
Traditional	158	101	-57	-36.1

Table 4 . Compound Annual Growth Rates of Production, Area and Yield of Sesame, 1961/62-1982/83, Sudan

Sector	Growth rate of		
	Production	Area	Yield
All Sudan	1.52	4.84	-3.17
Mechanized	9.49	11.52	-1.92
Traditional	0.32*	3.88	-3.71

* The growth rate is not significantly different from zero

Table 5 . Average Yearly Production of Sesame, in the Sudan :
 1961/62 to 1971/72 , 1972/73 to 1982/83 and 1979/80-
 1983/84

Sector	(000 MT)	Percent
<u>1961/62 to 1971/72</u>		
Mechanized	35	18.0
Traditional	159.8	82.0
Total	194.8	100
<u>1972/73 to 1982/83</u>		
Mechanized	71.4	30.1
Traditional	165.6	69.9
Total	237.0	100
<u>1979/80 to 1983/84</u>		
Mechanized	73	28.6
Traditional	182	71.4
Total	255	100

trend regression) of 4.84 percent and production grew at an annual rate of 1.52 percent (Table 4). During this period there also have been large intersectoral (Mechanized, traditional) and interregional changes in the production of and areas planted to sesame. For example, as an average for the 11-year period 1961/62 to 1971/72 a little over 18 percent of sesame was produced in the rainfed mechanized sector. For the period 1972/73 - 1982/83 it increased to 30.1 percent, and more recently during the 5-year period 1979/80 to 1983/84 the figure has been 28.6 percent (Table 5). This paper, therefore, aims at documenting the trends and changes in sesame production, areas and yields at the national and regional levels for the rainfed mechanized and rainfed traditional sector crops by using the time series data from 1961/62 to 1982/83. In describing the trends and patterns of change in the production of sesame we hope to increase our understanding of the nature and magnitude of instability of production, sources of increase in production, causes of yield decline and compare the mechanized and traditional sector crops.

The 22-year period of 1961/62 to 1982/83 is divided into two time periods of 11-years each; the first period from 1961/62 to 1971/72 and the second period from 1972/73 to 1982/83. Such a division allows comparisons of various trends and variability in production between the two periods and to comment upon changes in their magnitudes between the two periods, across regions and mechanized and traditional

sectors

II . Data Sources

The Department of Agricultural Economics and Statistics (DAES), Ministry of Agriculture and Natural Resources (MANR) Sudan , regulary reports area, yield and output data for sesame (and other crops) by provinces . All of the sesame crop is grown under rainfed conditions . The data for mechanized and traditional sectors are reported separately

Most MANR area and yield statistics for sesame crop have been subjective estimates . As yet there are no crop-cutting surveys for this crop

In the ensuing analysis, area, output and yield data for mechanized and traditional sectors are used for the period 1961/62 to 1982/83 , as reported by MANR in various issues of the Bulletin of Agricultural Statistics , Yearbook of Agricultural Statistics and Current Agricultural Statistics

III Changes at the National Level

A. Changes in Production

1. The average yearly production of sesame in the Sudan increased by 21.4 percent from 194000 MT during the first 11-year period 1961/62-1971/72 to 237000 MT during the second 11-year period 1972/73 to 1982/83 (Table 1) . Major part of this increase (86.3 percent) took place in the mechanized sector and only 13.7 percent in the traditional

sector . From first to the second period production in the mechanized sector increased by about 102.9 percent and in the traditional sector only by 3.6 percent. As a result the mechanized sector during the second period produced 30.1 percent of the total sesame output as compared to 18.1 percent during the first period ¹. As shown in Table 5, more recently this share of the mechanized sector during the 5 year period 1979/80 to 1983/84 has been 28.6 percent .

2. During the 22-year period national output of sesame grew at a modest annual rate of 1.52 percent. However, as discussed in the above section production in the mechanized sector grew at a relatively high annual rate of 9.49 percent whereas in the traditional sector the growth rate was not significantly different from zero (Table 4)

During the first period sesame production in the Sudan increased at a fairly high annual rate of growth of 3.64 percent but during the second period growth rate declined to -3.54 percent (Table 6) . In the mechanized sector the production during the first period grew at a rather rapid rate of 18.84 percent per annum but declined to -3.30 during the second period. And in the traditional sector it declined from a small positive growth rate of 0.69 percent to -3.35 percent . However, it should be pointed out that the growth rates of the second period have been pulled down by an exceptionally low level of production in 1982/83, the terminal year of our data, due to a severe drought .

1. These data are reported in Table 10

Table 6

Changes in Compound Annual Growth Rates of Production, Area and Yield of Sesame, 1961/62-1971/72 to 1972/73-1982/83, Sudan

Sector	Growth rate 1961/62- 1971/72	Growth rate 1972/73- 1982/83	Change
<u>Production</u>			
All Sudan	3.64	-3.54	-7.18
Mechanized	18.84	-3.30	-22.14
Traditional	0.69*	-3.35	-4.04
<u>Area</u>			
All Sudan	7.42	-2.45	-9.87
Mechanized	21.45	-2.76	-24.21
Traditional	4.83	-2.21	-7.04
<u>Yield</u>			
All Sudan	-3.49	-1.01	2.48
Mechanized	-2.23*	-0.83*	1.40
Traditional	-4.05	-1.18*	2.87

* The regression coefficient from which these growth rates are calculated are not significantly different from zero.

3. As shown in Table 7 the yearly production of sesame in the Sudan, varied during the 22 years from a low of 133000 MT in 1966/67 to a high of 340000 MT during 1972/73 with a coefficient of variation of 24.9 percent. Production was more variable in the mechanized sector (CV=55.6 percent) than the traditional sector (CV=30.8 percent)

However, the yearly level of production of sesame became more stable during the second 11-year period than during the first 11-year period. As shown in Table 8 both the absolute (standard deviation) and relative (coefficient of variation) variability in the yearly production declined considerably from 80.0 percent to 24.9 percent in the mechanized sector, from 38.5 percent to 22.6 percent in the traditional sector and from 29.4 percent to 17.9 percent for all Sudan

B. Changes in Areas

1. Average yearly areas planted to sesame in the Sudan increased by 77.6 percent from 1239000 FD during the first 11-year period to 2201000 FD during the second period (Table 3). Areas in the mechanized sector increased at a faster rate than the traditional sector and from first to the second period increased by 146 percent from 226000 FD to 556000 FD. In the traditional sector areas increased by 62.4 percent from 1013000 FD to 1645000 FD. As a consequence of these changes the share of the mechanized sector in the total areas planted to sesame in the Sudan increased from 18 percent in the first period to 25 percent in the second period, and the share of

Table 7 . Average Production, Area and Yield of Sesame, 1961/62-1982/83, Sudan

Production in 000 MT
 Area in 000 FD
 Yield in Kilograms/FD

Sector	Average	Minimum	Maximum	Coefficient of variation
		<u>Production</u>		
All Sudan	216	133(66/67)	340(72/73)	24.9
Mechanized	53	4(64/65)	111(77/78)	55.6
Traditional	162	74(68/69)	297(70/71)	30.8
		<u>Area</u>		
All Sudan	1720	776(62/63)	2847(72/73)	33.8
Mechanized	391	28(64/65)	732(73/74)	57.6
Traditional	1,329	696(62/63)	2847(72/73)	31.7
		<u>Yield</u>		
All Sudan	126	82(82/83)	238(61/62)	26.6
Mechanized	136	78(61/62)	394(62/63)	41.4
Traditional	122	60(70/71)	264(61/62)	35.0

Table 8 . Changes in Coefficient of Variation of Production, Area and Yield of Sesame, 1961/62-1971/72 to 1972/73-1982/83, Sudan

Sector	Coefficient of variation (%)		Change (%)
	1961/62-1971/72	1972/73-1982/83	
	<u>Production</u>		
All Sudan	29.4(57.1)	17.9(42.4)	-39.1(-25.7)
Mechanized	80.0(28.0)	24.9(17.8)	-68.9(-36.4)
Traditional	38.5(61.2)	22.6(37.5)	-41.3(-38.7)
	<u>Area</u>		
All Sudan	29.7(367.8)	11.4(250.9)	-61.6(-31.8)
Mechanized	84.8(191.3)	17.9(99.4)	-78.9(-48.0)
Traditional	29.8(302.0)	15.2(250.3)	-49.0(-17.1)
	<u>Yield</u>		
All Sudan	19.9(31.7)	9.3(9.9)	-53.3(-70.7)
Mechanized	47.2(81.3)	18.3(23.7)	-61.2(-70.9)
Traditional	28.2(44.3)	13.9(13.4)	-50.7(69.8)

Note : Figures in parentheses are standard deviations .

the traditional sector dropped from 82 percent to 75 percent (Table 3). However, a much larger part (65 percent) of the total increase of 963000 FD in the average yearly areas planted to sesame, occurred in the traditional sector as compared to 34 percent in the mechanized sector. In other words, the absolute increase of areas planted was approximately double in the traditional sector to that of the mechanized sector.

2. The annual growth rates of area planted to sesame were high during the first period. The maximum area of 2847000 FD planted to sesame in the Sudan was during the year 1972/73 and negative growth rates are observed in all sectors during the second period. The exceptionally high levels of planting in 1972/73 the first year of the second 11-year period and exceptionally low level of planting during the terminal year of 1982/83 due to severe drought, have caused the growth rates during the second period to be negative. Otherwise the yearly areas planted to sesame from 1973/74 to 1981/82 seem to be fairly stable.

3. For the 22-year period the areas planted to sesame in the Sudan varied from a low of 776000 FD during 1962/63 to a high of 2847000 FD during 1972/73 with a coefficient of variation of 33.8 percent. However, the variability in areas planted to sesame decreased substantially from first to the second period in absolute as well as relative terms in both (mechanized and traditional) the sectors as well as for all Sudan. The coefficients of variation for the second period for all Sudan and mechanized

and traditional sectors are 11.4 percent, 17.9 percent and 15.2 percent, respectively

C. Changes in Yields

1. The average sesame yield for all Sudan declined by 49 Kgs/FD (31.2 percent) from 157 Kgs/FD in the first period to 108 Kgs/FD during the second period. The decline was considerably smaller in the mechanized sector where the yields decreased by 27 Kgs/FD (17.4 percent) from 155 Kgs/FD in the first period to 126 Kgs/FD during the second period. In the traditional sector the yield declined by 57 Kgs/FD from 158 Kgs/FD to 101 Kgs/FD

2. For the 22-year period sesame yields in the Sudan declined at an average annual rate of -3.17 percent. This rate of decline was -1.92 percent in the mechanized sector and -3.71 percent in the traditional sector. However, these decline rates were much larger (in absolute values) during the first period and became smaller during the second period. As a matter of fact in both sectors (mechanized and traditional) the decline rates during the second period are statistically not significantly different from zero.

3. During the 22-year period the national average yields of sesame in the Sudan varied from a low of 82 Kgs/FD to a high of 238 Kgs/FD with a coefficient of variation of 26.6 percent. In the mechanized sector they varied from a low of 78 Kgs/FD to a high of 394 Kgs/FD with the coefficient of variation of 41.4 percent and in the traditional sector they varied from 60 Kgs/FD to 264 Kgs/FD with the coefficient of

variation of 35.0 percent (Table 7)

The variability in sesame yields in absolute as well as relative terms decreased substantially from first to the second period in both mechanized and traditional sectors as well as for all Sudan. During the second period the coefficient of variation for all Sudan was 9.3 percent, for the mechanized sector 18.3 percent and for the traditional sector 13.9 percent (Table 8).

IV Changes at the Regional Level

A. Changes in Production

1. In Tables 9 and 10 the yearly average production of sesame is presented by region and by sector for the two 11-year periods. The data are organized to show changes from first to the second period and relative sectoral and regional shares. The yearly average level of production of sesame in the Sudan increased by 42200 MT (approximately 22 percent) from 194800 MT during the first 11-year period to 237000 MT during the second 11-year period. This increase was shared by all regions except the Blue Nile where the average yearly production decreased by 16000 MT (20 percent) from 79800 MT in the first period to 63800 MT during the second period. The traditional sector production in this region declined by 24200 MT but there was an increase in the mechanized production of 8200 MT

From first to the second period, the largest increase of 23500 MT in sesame production occurred in the Kordofan region followed by 18000 MT in the Southern region, 9200 MT in Kassala region and 7500 MT in Darfur regio

Table 9 . Average Production of Sesame by Region and by Sector, 1961/62-1971/72 and 1972/73-1982/83, Sudan

Region/ Sector	1961-62 1971/72	1972/73- 1982/83	Change	Change (%)	Change as % of Total
<u>Average production (000 MT)</u>					
<u>Kassala</u>					
Mechanized	26.7(73)	45.9 (100)	19.2	71.9	
Traditional	10.0(27)	-	-10.0	-100.0	
Total	36.7 (18.8)	45.9 (19.3)	9.2	25.1	21.8
<u>Blue Nile</u>					
Mechanized	7.9(10)	16.1(25)	8.2	103.8	
Traditional	71.9(90)	47.7(75)	-24.2	-33.7	
Total	79.8 (41.0)	63.8 (26.9)	-16.0	-20.0	-37.9
<u>Kordofan</u>					
Mechanized	- (0)	4.9(5)	4.9	-	
Traditional	64.9(100)	83.5(95)	18.6	28.7	
Total	64.9 (33.3)	88.4 (37.3)	23.5	36.2	55.7
<u>Darfur</u>					
Traditional	6.5(100) (3.3)	14.0(100) (5.9)	7.5	115.4	17.8
<u>Southern</u>					
Mechanized	0.4(6)	4.5(18)	4.1	1025.0	
Traditional	6.5(94)	20.4(82)	13.9	213.8	
Total	6.9 (3.5)	24.9 (10.5)	18.0	260.9	42.7
<u>All Sudan</u>	194.8 (100)	237.0 (100)	42.2	21.7	(100)

Table 10 . Changes in Average Sesame Production from 1961/62-1971/72 to 1972/73-1982/83 for Mechanized and Traditional Sectors by Region, Sudan

(000 MT)

Region	1961/62- 1971/72	1972/73- 1982/83	Change	Change (%)	Change as % of Total
<u>Mechanized</u>					
Kassala	26.7 (76)	45.9 (64)	19.2	71.9	52.7
Blue Nile	7.9 (23)	16.1 (23)	8.2	103.8	22.5
Kordofan	-	4.9 (7)	4.9	-	13.5
Southern	0.4 (1)	4.5 (6)	4.1	1025.0	11.3
All Sudan (Mechanized)	35.0 (100)	71.4 (100)	36.4	102.9	(100)
Percent of total	(18.1)	(30.1)	(86.3)		
<u>Traditional</u>					
Kassala	10.0 (6)	- (0)	-10.0	-100.0	-72.4
Blue Nile	71.9 (45)	47.7 (29)	-24.2	-33.7	-17.2
Kordofan	64.9 (41)	83.5 (50)	18.6	28.7	20.6
Darfur	6.5 (4)	14.0 (8)	7.5	115.4	129.3
Southern	6.5 (4)	20.4 (13)	13.9	213.8	239.7
All Sudan (Traditional)	159.8(100)	165.6(100)	5.6	3.6	(100)
Percent of total	(82.0)	(69.9)	(13.7)		
All Sudan (Mechanized + Tradition- al)	194.8	237.0	42.2	21.7	

As a result of the disparate rates at which these increases occurred the relative shares of different regions in total production of sesame in the Sudan, also changed from first to the second period. The share of Blue Nile dropped from 41.0 percent during the first period to 26.9 percent during the second period, and that of Kordofan increased from 33.3 percent to 37.3 percent. Thus, Kordofan during the second period was the largest sesame producing region in the Sudan, and on an average produced 38.6 percent more sesame than the Blue Nile which was the largest producer during the first period. The share of Kassala increased marginally from 18.8 percent to 19.3 percent and of Darfur from 3.3 percent to 5.9 percent. Sesame production in the Southern region also increased quite rapidly and its share increased from 3.5 percent to 10.5 percent.

At the same time production of sesame increased much more rapidly in the mechanized sector than in the traditional sector. Out of a total increase of 42200 MT in average yearly production from first to the second period 86.3 percent occurred in the mechanized sector where production increased by 102.9 percent from 35000 MT to 71400 MT. Only 13.7 percent of the increase occurred in the traditional sector where production increased by 3.6 percent from 159800 MT in the first period to 165600 MT in the second period. Consequently the relative share of the mechanized production in the total sesame output increased from 18.1 percent in the first period to

Table 11 . Compound Annual Growth Rates of Production of Sesame
by Region and by sector, 1961/62-1971/72, 1972/73-1982/83
/83 and 1961/62-1982/83, Sudan

Region/Sector	Growth rate 1961/62- 1971/72	Growth rate 1972/73- 1982/83	Change	Growth rate 1961/62- 1982/83
<u>Kassala</u>				
Mechanized	16.64	-4.82	-21.46	7.02
<u>Blue Nile</u>				
Mechanized	32.05	-1.50	-29.82	15.45
Traditional	-2.62	-3.00	-0.97	-3.73
Total	-2.30	-2.70	-0.43	-1.81
<u>Kordofan</u>				
Mechanized	-	10.01	-	-
Traditional	8.00	-5.78	-13.8	-2.46
Total	8.00	-5.48	-13.4	2.94
<u>Darfur</u>				
Traditional	3.78	2.97	-0.81	6.83
<u>Southern</u>				
Mechanized		-2.73*	-	-
Traditional	10.92	6.02	-4.90	13.13
Total	13.21	4.94	-8.27	13.70

Table 12 . Changes in Coefficient of Variation of Production of Sesame by Region and by Sector, 1961/62-1971/72 to 1972/73-1982/83, Sudan

Region/Sector	1961/62 to 1971/72	1972/73 to 1982/83	Change %
<u>Coefficient of Variation %</u>			
Kassala			
Mechanized	64.7(17.3)	34.9(16.0)	-46.1
Blue Nile			
Mechanized	207.7(18.1)	41.5(6.7)	-80.0
Traditional	39.8(31.5)	23.1(11.0)	-42.0
Total	38.0(30.3)	18.9(12.0)	-50.3
Kordofan			
Mechanized	-	73.7(3.6)	-
Traditional	62.5(40.6)	39.6(33.0)	-36.6
Total	62.5(40.6)	36.1(31.9)	-42.2
Darfur			
Traditional	49.9(3.6)	24.3(3.4)	-51.3
Southern			
Mechanized	-	49.6(2.3)	-
Traditional	100.1(6.6)	28.6(5.9)	-71.4
Total	93.2(6.6)	25.7(6.4)	-72.4

30.1 percent in the second period and share of the traditional sector declined from 82.0 percent to 69.9 percent

In order to develop a clearer view of changes, this picture of overall sectoral changes has to be supplemented by sectoral changes within regions. For example, in the Kordofan region mechanized production increased only by 4900 MT (13.5 percent of the total increase in mechanized production) whereas production in the traditional sector increased by 18600 MT approximately 380 percent of the increase in the mechanized sector. In Southern region traditional production increased by 213.8 percent from 6500 MT in the first period to 20400 MT in the second period and in Darfur it increased by 115.4 percent from 6500 MT to 14000 MT. However, it decreased substantially by 24200 MT in Blue Nile and 10000 MT in Kassala. The overall increase only of 5600 MT in the traditional sector, therefore, does not show a clear picture. Traditional production of sesame increased considerably in the regions of Kordofan, Darfur and Southern, but was replaced substantially in Kassala and Blue Nile regions by mechanized production which increased most in these two regions

2. The high growth rates of sesame production in the first period declined in all regions during the second period and except Darfur and Southern regions became negative.

3. Variability in yearly production of sesame in absolute (standard deviation) as well as relative (coefficient of variation) terms decreased substantially from first to the second period in all regions and sectors

B. Changes in Areas

1. With one exception output changes discussed in the above section correspond to changes in areas planted to sesame as shown in Tables 13 and 14 . The exception is the traditional sector of the Blue Nile region where average yearly areas planted to sesame increased by 35000 FD (2.5 percent) from 293000 FD in the first 11-year period to 328000 FD in the second 11-year period, but production decreased by 18600 MT (Tables 9 and 10) . At the same time, mechanized areas in this region increased by 106000 FD (2.00 percent) from 45000 FD to 151000 FD . It seems that expansion of mechanized production in this region, pushed traditional production of sesame into relatively less productive areas . The share of the Blue Nile region in total areas planted to sesame in the Sudan decreased from 27.3 percent in the first period to 21.8 percent in the second period but the share of the mechanized sector within the region increased from 13 percent to 31 percent . Also the share of the mechanized areas in Blue Nile region increased in the total mechanized sesame areas in the Sudan from 20 percent to 27.1 percent

In Kassala region there were on an average 76000FD per year under traditional production during the first period . However, there were no areas under traditional production

Table 13 . Average Area of Sesame by Region and by Sector
1961/62-1971/72 and 1972/73-1982/83, Sudan

Region/ Sector	1961-62 1971/72	1972/73- 1982/83	Change	Change (%)	Change as % of Total
<u>Average Area in (000 MT)</u>					
<u>Kassala</u>					
Mechanized	176(70)	327 (100)	151	85.8	15.0
Traditional	76(30)	- (0)	-76	-100.0	-7.9
Total	525 (20.4)	327 (14.9)	75	29.8	7.8
<u>Blue Nile</u>					
Mechanized	45(13)	151(31)	106	200.0	11.0
Traditional	293(87)	328(69)	35	2.5	3.7
Total	338 (27.3)	479 (21.8)	141	29.0	14.6
<u>Kordofan</u>					
Mechanized	- (0)	37(3.5)	37	-	3.8
Traditional	541(100)	1,015(96.5)	474	87.6	49.2
Total	541(100) (43.7)	1,052(100) (47.8)	511	94.5	53.0
<u>Darfur</u>					
Traditional	63(100) (5.1)	165(100) (7.5)	102	161.9	10.6
<u>Southern</u>					
Mechanized	4(9)	41(23)	37	925	3.8
Traditional	40(91)	137(77)	97	242.5	10.1
Total	44 (3.5)	178 (8.0)	134	304.5	13.9
<u>All Sudan</u>	1238 (100)	2201 (100)	963	77.8	(100)

Table 14 .Changes in Average Sesame Areas from 1961/62-1971/72 to 1972/73-1982/83 for Mechanized and Traditional Sectors by Region, Sudan

(000 FD)

Region	1961/62- 1971/72	1972/73- 1982/83	Change	Change (%)	Change as of Total
			<u>Mechanized</u>		
Kassala	176 (78)	327 (59.0)	151	85.8	45.6
Blue Nile	45 (20)	151 (27.1)	106	200.0	32.0
Kordofan	- (0)	37 (6.7)	37	-	11.2
Southern	4 (2)	41 (7.2)	37	-	11.2
All Sudan (Mechanized)	225 (100)	556 (100)	331	146.2	(100)
Percent of total	(18.2)	(25.3)	(34.4)		
			<u>Traditional</u>		
Kassala	76 (7)	- (0)	-76	100.0	-12.0
Blue Nile	293 (30)	328 (20)	35	2.5	5.5
Kordofan	541 (53)	1015 (62)	474	88.9	75.0
Darfur	63 (6)	165 (10)	102	160.3	16.1
Southern	40 (4)	137 (8)	97	234.2	15.4
All Sudan (Traditional)	1013 (100)	1645 (100)	632	70.9	(100)
Percent of total	(81.8)	(74.7)	(65.6)		
All Sudan (Mechanized & Tradition- al)	1238	2201	963	79.8	

during the second period . Mechanized areas on the other hand increased by 151000 FD (85.8 percent) from 176000 FD to 327000 FD . Mechanized production also increased in Kordofan and Southern (Upper Nile) regions by 37000 FD in each case . In the Sudan as a whole, the mechanized areas planted to sesame increased by 331000 FD from 225000 FD to 556000 FD and share of mechanized areas in total areas planted to sesame in Sudan increased from 18.2 percent to 25.3 percent

Largest increases in areas under traditional production occurred in the Kordofan (474000 FD) , Darfur (102000 FD) and Southern (97000 FD) . For the Sudan as a whole areas under traditional production of sesame increased by 632000 FD almost twice the increase in mechanized areas . However, the percent share of the traditional sector in areas planted to sesame in Sudan declined from 81.8 percent to 74.7 percent

2. For the 22-year period the growth rates of areas planted to sesame were positive in all regions and sectors and were generally quite high . Only the traditional sector in the Blue Nile region had an insignificant rate of growth in areas planted to sesame . In the traditional sectors of Darfur, Blue Nile and Southern regions, the growth rates of areas planted to sesame increased from first to the second period but declined in the Kordofan region where expansion of areas was the largest . The growth rates also declined in the mechanized sectors of Kassala and Blue Nile

Table 15 . Compound Annual Growth Rates of Areas of Sesame
by Region and by Sector, 1961/62-1971/72, 1972/73-1982
/83 and 1961/62-1982/83, Sudan

Region/Sector	Growth rate 1961/62- 1971/72	Growth rate 1972/73- 1982/83	Change	Growth rate 1961/62- 1982/83
<u>Kassala</u>				
Mechanized	19.43	-5.44	-24.87	8.10
<u>Blue Nile</u>				
Mechanized	35.58	0.12*	-35.46	20.43*
Traditional	-1.81*	1.11	2.92	0.44*
Total	-0.50	1.03	1.53	2.88
<u>Kordofan</u>				
Mechanized	-	4.82*	-	-
Traditional	14.60	-5.32	-19.92	6.13
Total	14.63	-5.21	-19.84	6.49
<u>Darfur</u>				
Traditional	6.25	8.87	2.62	8.93
<u>Southern</u>				
Mechanized	-	-5.75	-	-
Traditional	-1.22*	9.22	10.44	12.03
Total	-3.14*	5.83		13.34

Table 16 . Changes in Coefficient of Variation of Area of Sesame
by Region and by Sector, 1961/62-1971/72 to 1972/73-
1982/83, Sudan

Region/Sector	1961/62 to 1971/72	1972/73 to 1982/83	Change %
	<u>Coefficient of Variation %</u>		
Kassala			
Mechanized	70.6(124.2)	23.4(76.6)	-66.9
Blue Nile			
Mechanized	206.0(101.1)	47.3(71.5)	-77.0
Traditional	41.7(134.3)	14.3(46.8)	-65.7
Total	37.8(127.5)	11.0(52.9)	-70.9
Kordofan			
Mechanized	-	72.2(26.9)	-
Traditional	58.8(317.6)	29.9(303.6)	-49.1
Total	58.8(318.7)	28.2(296.5)	-52.0
Darfur			
Traditional	39.1(24.7)	35.5(58.6)	-9.2
Southern			
Mechanized	-	50.8(20.7)	-
Traditional	117.5(46.9)	28.5(38.9)	-75.7
Total	105.4(46.6)	24.6(43.5)	-76.7

3. The variation in yearly areas planted to sesame decreased from first to the second period in absolute as well as relative terms, except that in the traditional sector of Darfur region the standard deviation increased from 24.7 to 58.6

C. Changes in Yields

1. As shown in Tables 17 and 18 the average sesame yields declined in all regions and sectors except for a small increase in the mechanized production in the Southern (Upper Nile) region. The decline was larger (53 Kgs/FD) in the traditional sector than (27 Kgs/FD) in the mechanized sector

2. Also the growth rates of sesame yields for the 22-year period were negative in all regions and sectors except the Southern region where a small positive growth rate is observed (Table 19). However, the large decline rates (in absolute values) of the first period in the important mechanized sectors of Kassala and Blue Nile and the traditional sector of Kordofan became much smaller during the second period. Actually in the mechanized sector of Kassala region a small positive (but nonsignificant) growth rate is observed during the second period. Also in the mechanized sectors of Kordofan and Southern regions the yield growth rates during the second period were positive. As a result of these changes (as shown in Table 6) the growth rates of sesame yields in the mechanized as well as the traditional sectors and for the Sudan as a whole, even though

Table 17 . Average Yield of Sesame by Region and by Sector, 1961/62-1971/72 and 1972/73-1982/83

Sector	1961-62- 1971/72	1972/73- 1982/83	Change	Change %
<u>Average yield (Kgs/FD)</u>				
<u>Kassala</u>				
Mechanized	152	142	-10	-6.6
Traditional	132	-	-	-
Total	146	142	-2	-1.4
<u>Blue Nile</u>				
Mechanized	176	107	-69	-39.2
Traditional	245	145	-100	-40.8
Total	236	133	-103	-43.6
<u>Kordofan</u>				
Mechanized	-	132	-	-
Traditional	120	82	-38	-31.7
Total	120	84	-36	-30.40
<u>Darfur</u>				
Traditional	103	85	-18	-17.5
<u>Southern</u>				
Mechanized	100	110	10	10.0
Traditional	162	149	-13	-8.0
Total	157	140	-17	-10.8

Table 18 . Changes in Average Yield of Sesame from 1961/62-1971/72 to 1972/73-1982/83 for Mechanized and Traditional Sectors by Region, Sudan

(Kgs/HD)

Region	1961/62-1971/72	1972/73-1982/83	Change	Change (%)
		<u>Mechanized</u>		
Kassala	152	142	-10	-6.6
Blue Nile	176	107	-69	-39.4
Kordofan	-	132	-	-
Southern	100	110	10	10.0
All Sudan (Mechanized)	155	128	-27	-17.4
		<u>Traditional</u>		
Kassala	132	-	-	-
Blue Nile	245	145	-100	-40.8
Kordofan	120	82	-38	-31.7
Darfur	103	85	-18	-17.5
Southern	162	149	-13	-8.0
All Sudan (Traditional)	158	101	-56	-36.1
All Sudan (Mechanized+Traditional)	157	108	-53	-31.8

Table 19 . Compound Annual Growth (Decline) Rates of Yield of Sesame by Region and by sector, 1961/62-1971/72, 1972/73-1982/83 and 1961/62-1982/83, Sudan

Region/Sector	Growth rate 1961/62- 1971/72	Growth rate 1972/73- 1982/83	Change	Growth rate 1961/62- 1982/83
<u>Kassala</u>				
Mechanized	-2.34*	0.67*	3.01	-1.09
<u>Blue Nile</u>				
Mechanized	-5.57	-1.61	3.96	-4.69
Traditional	-0.89	-4.09	-3.20	-4.18
Total	-1.80*	-3.70	-1.90	-4.57
<u>Nordofan</u>				
Mechanized		4.95	-	-
Traditional	-5.79	-0.48	5.31	-3.53
Total	-5.79	-0.09	5.70	-3.26
<u>Darfur</u>				
Traditional	-2.33	-4.76	-2.43	-2.07
<u>Southern</u>				
Mechanized	-	3.20	-	-
Traditional	12.20	-2.57	-14.77	0.57
Total	9.76	-0.86	-10.62	0.34

Table 20 . Changes in Coefficient of Variation of Yield of Sesame by Region and by Sector, 1961/62-1971/72 to 1972/73-1982/83, Sudan

Region/Sector.	1961/62 to 1971/72	1972/73 to 1982/83	Change %
	<u>Coefficient of Variation %</u>		
Kassala			
Mechanized	50.3(84.5)	19.7(27.3)	-30.8
Blue Nile			
Mechanized	37.2(78.6)	25.9(28.9)	-30.4
Traditional	53.4(145.3)	18.7(27.1)	-65.0
Total	51.6(133.4)	19.1(25.6)	-63.0
Kordofan			
Mechanized	-	23.4(31.0)	-
Traditional	29.2(36.9)	10.6(8.6)	-63.7
Total	29.2(36.9)	11.0(9.2)	-62.3
Darfur			
Traditional	28.2(29.5)	34.3(30.6)	11.6
Southern			
Mechanized	-	22.6(26.7)	-
Traditional	56.2(107.3)	32.5(52.7)	-22.2
Total	54.4(96.7)	26.1(38.4)	-52.0

negative are not statistically significantly different from zero during the second period .

3. As shown in Table 20 the variability of sesame yields in absolute (standard deviation) as well as relative (coefficient of variation) terms decreased substantially in all regions and sectors except a slight increase in the standard deviation in the traditional sector of Darfur region

V Sesame Yields and Stability of Production

Sesame production in the Sudan increased rapidly from 1961/62 to 1972/73 and peaked off after that . It was fairly stable from 1973/74 to 1981/82. But was quite variable for the period 1961/62-1982/83 . The coefficient of variation in the yearly production was 24.9 percent

During this period areas planted to sesame increased at an annual compound rate of growth of 4.48 percent but production increased only at the rate of 1.52 percent and the national average yield decreased at the rate of 3.17 percent . The rates of yield decline were faster during the first 11-year period and became much smaller during the second 11-year period and generally seem to follow the rates of increase in areas planted to sesame in various regions and sectors which have themselves been quite disparate . In this section three regression estimates are presented, the first two (1) to indicate the impact of growth of crop areas planted to sesame and sorghum, of mechanization

Table 21 Growth Rates of Sesame Yield and Area, 1961/62-1971/72 and 1972/73-1982/83, Sudan

	GRY	GRA	DM	DP	GRAS
<u>First = period 1961/62 -1971/72</u>					
Kassala (M)	-2.34	19.43	1	0	14.30
Blue Nile (M)	-5.57	35.58	1	0	12.81
Blue Nile (T)	-0.89	-1.81	0	0	-0.48
Kordofan (T)	-5.79	14.60	0	0	7.55
Darfur (T)	-2.33	6.25	0	0	6.43
Southern (T)	12.20	-1.22	0	0	1.26
<u>Second period = 1972/73 -1982/83</u>					
Kassala (M)	0.67	-5.44	1	1	6.16
Blue Nile (M)	-1.61	0.12	1	1	7.87
Blue Nile (T)	-4.09	1.11	0	1	4.33
Kordofan (M)	4.95	4.82	1	1	-1.77
Kordofan (T)	-0.48	-5.32	0	1	2.24
Darfur (T)	-4.76	8.87	0	1	10.97
Southern (M)	3.20	-5.57	1	1	
Southern (T)	-2.57	9.22	0	1	8.57

Notes : M = Mechanized; T = Traditional;
 GRY = Growth rate of yield; GRA = Growth rate of area planted to sesame
 DM = Dummy variable, one for mechanized areas
 DP = Dummy variable, one for the period 1972/73-1982/83
 GRAS = Growth rate of area planted to sorghum

Table 22 Coefficients of Variation of Production, Area and Yields, of Sesame 1961/62-1971/72 and 1972/73-1982/83, Sudan

	CVP	CVA	CVY	DM	DP
<u>First = period 1961/62 -1971/72</u>					
Kassala (M)	64.7	70.6	50.3	1	0
Blue Nile (M)	207.7	206.0	37.2	1	0
Blue Nile (T)	39.8	41.7	53.4	0	0
Kordofan (T)	62.5	58.8	29.2	0	0
Darfur (T)	49.9	39.1	28.2	0	0
Southern (T)	100.1	117.5	56.2	0	0
<u>Second period = 1972/73 -1982/83</u>					
Kassala (M)	34.9	23.4	19.7	1	1
Blue Nile (M)	41.5	47.3	25.9	1	1
Blue Nile (T)	23.1	14.3	18.7	0	1
Kordofan (M)	73.7	72.2	23.4	1	1
Kordofan (T)	39.6	29.9	10.6	0	1
Darfur (T)	24.3	35.5	34.3	0	1
Southern (M)	49.6	50.8	22.6	1	1
Southern (T)	28.6	28.5	32.5	0	1

Notes : M, T, DM and DP as in Table 21 above and CVP, CVA and CVY are coefficient of variation of production; area and yield, respectively.

and of change in time periods on growth in yields, and the third (2) to study the impact of variations in yearly areas planted to sesame and sesame yields, of mechanization and of change in time periods on the variability in annual production of sesame

$$(1) \text{ GRY} = 2.197 - 0.329 \text{ GRA} + 3.011 \text{ DM} - 3.968 \text{ DP}$$

$$(2.672) \quad (1.247) \quad (1.450)$$

$$R^2 = 0.423; \quad n = 14$$

The figures in the parentheses are the absolute t-values

GRY = The annual rate of growth in sesame yield in a particular sector (mechanized or traditional) in a given region for the 11-year period

GRA = The annual rate of growth of areas planted to sesame in a particular sector in a given region for the 11-year period

DM = One for the mechanized sector and zero for the traditional sector

DP = Zero for the period 1961/62 - 1971/72 and, one for the period 1972/73 - 1982/83

The data for regression (1) are presented in Table (21)

$$(2) \text{ GRY} = 0.578 - 0.437 \text{ GRAS} + 2.248 \text{ DM} - 0.272 \text{ DP}$$

$$(1.754) \quad (0.752) \quad (0.100)$$

$$R^2 = 0.257; \quad n = 13$$

The figures in the parentheses are the absolute t-values

GRAS = The annual rate of growth of areas planted to sorghum in a particular sector in a given region for the 11-year period

Other variables are as defined in equation (1) above .

$$(3) \text{ CVP} = 32.586 + 0.950 \text{ CVA} - 0.712 \text{ CVY} + 1.644 \text{ DM} - 13.150 \text{ DT}$$

(24.032) (4.776) (0.504) (2.938)

$$R^2 = 0.992; \quad n = 14 .$$

The figures in the parentheses are the absolute t-values

CVP, CVA and CVY = The coefficients of variation of yearly production of, areas planted to and yields of sesame for the 11-year period in a particular sector in a given region

DM and DT = As defined above in equation (1)

A. The results of regressions (1) and (2) presented above are summarized below

1. The rate of expansion of areas planted to sesame, holding constant the influences of mechanization and change of time period, negatively influenced the rate of yield increase

Holding constant the impacts due to change of time period and expansion of areas planted to sesame, the yield of sesame declined at a slower rate in mechanized areas than the traditional areas.

3. According to the first regression the yield of sesame, holding constant the impacts of growth in areas planted to sesame and of mechanization, decreased at a faster rate during the second period than during the first

period . It has been suggested that there has been an increase of "Striga" infestation which primarily affects sorghum overtime . Farmers, therefore tend to plant sesame in areas infested with "Striga" which makes weed control more difficult and thus might have lead to an overtime decline in sesame yields

Regression (2) appears to lend some support to this notion . It is based on the assumption that overtime spread of infestation of "Striga" can be represented by the expansion rates of areas planted to sorghum . However, to the extent that the growth rates of areas planted to sesame and sorghum are correlated, the variable GRAS may be estimating the impact of expansion of sesame areas on yields . This intercorrelation problem also prevented us from including GRAS directly into equation (1)

B. The results of regression (3) are as follows

4. The variability in yearly production of sesame in the Sudan is increased, holding constant the impact of variability in yields, the effect of mechanization and change of time period, by increased variability of areas planted to sesame

5. On the other hand, increased variability of sesame yields, holding constant the impacts of variability of areas, mechanization and change of time periods, decreases the variability in yearly production of sesame

6. Holding constant, the impacts of variability in areas and yields and of change of time period, the variability of sesame production in the mechanized and traditional areas is the same. That is, the variability in sesame production is not influenced by mechanization as such

7. Holding constant the impact of variability of areas and yields and of mechanization, the variability of yearly sesame production is less during the second period. That is, overtime, sesame production became more stable

VI Summary and Implications of the Results

1. The purposes of this paper are (1) to describe trends and patterns of change in the production of sesame in the Sudan at the national and regional levels for rainfed mechanized and rainfed traditional crops, over the 22-year period from 1961/62 to 1982/83, (2) to examine changes in the overtime stability of production, (3) to examine sources of growth of production of sesame, (4) to examine the pattern and causes of yield changes, and (5) to compare the mechanized and traditional crops. For comparative purposes the 22-year period is divided into two equal time periods of 11-years; the first period from 1961/62 to 1971/72 and the second period from 1972/73 to 1982/83.

2. The time series data used in the analysis are as reported by the Ministry of Agriculture and Natural Resources in various issues of the Bulletin of Agricultural Statistics, Yearbook of Agricultural Statistics and Current Agricultural Statistics.

During the 22-year period 1961/62 to 1982/83 area planted to sesame in the Sudan increased at an annual compound rate of growth of 4.84 percent and production of sesame increased at the rate of 1.52 percent. In the mechanized sector these rates were 11.52 percent and 9.49 percent respectively. But in the traditional sector the rate of increase in production was only 0.32 percent.

(statistically nonsignificant) inspite of the fact that areas increased at the rate of 3.88 percent . As a result, the shares of the mechanized sector in area and production of sesame in the Sudan increased from the first 11-year period to the second 11-year period from 18 percent to 25 percent and 18 percent to 30 percent, respectively. However, the relative importance of sesame in the production of five major food crops¹ in the Sudan declined from 8.8 percent to 6.7 percent, and at the same time high growth rates of the first period became negative during the second period because of an exceptionally low level of production in 1982/83, the terminal year of the data series, due to a severe drought.

4. From first to the second period production of sesame in the traditional sector increased considerably in the regions of Kordofan, Darfur and Southern but was replaced substantially in Kassala and Blue Nile regions by mechanized production which increased most in these two regions . Kordofan is the largest sesame producing region in the Sudan with a share of 37.3 percent in the total production.

5. The variability in the yearly production of sesame decreased substantially from first to the second period in all regions and sectors, and the Sudan as a whole .

6. The average sesame yields declined from first 11-year period to the second 11-year period in all regions and sectors except for a small increase in the mechanized Sorghum, Wheat, Millet, Sesame and Groundnuts

production in the Southern (Upper Nile) region. The decline was larger in the traditional sector (53 Kgs/FD) than in the mechanized sector (27 Kgs/FD). The rates of yield decline were much larger (in absolute values) during the first period than the second period. As a matter of fact the decline rates during the second period are statistically not significantly different from zero. However, the yield variability increased from first to the second period.

The regression results indicate that the decline in sesame yields has been strongly influenced by the rate expansion of areas planted to sesame as well as sorghum. The influence of expansion of sorghum areas may in part be due to "Striga Influence", which pushes sesame production into relatively more weed infested areas. The decline in sesame yields has been less in mechanized areas than in the traditional areas.

8. The yearly variation in sesame production is strongly influenced by increased variability of areas planted but is decreased by variability of yield. However, the production variability is not influenced by mechanization and has decreased overtime.

Appendix

