The Impact of Economic Factors on Sorghum Production in Mechanized Farming in Northern and Southern Gadarif Area

By

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DEDICATION

For

Those who are willing to educate…

To my dear father, mother,

Brothers, sisters,

Mohammed,

Relatives and

friends.

I dedicate this work with my love…

Eiman 2005

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Thanks to Allah who helped me to complete this study. I wish to express my sincere thanks and gratitude to my Supervisor Dr. Ali Abdel Aziz Salih for patience and supervision of this study.

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ABSTRACT

This study was conduced in Gadarif State, privileged with good climate for production of sorghum and sesame under rainfall conditions. The purpose of this study was to assess the impact of socio- economic factors on sorghum crop production in the study area. To achieve this objective the study used descriptive statistics, budget analysis and multiple regression analyses to give out needed indicators.

Primary and secondary data were used for the analysis. The primary data was collected from a field survey in northern and southern Gadarif for the season 2004/2005. The selected random sample included fifty-two respondents. The study results revealed that most of respondents were in the active age group, with secondary and university education. They managed agriculture schemes ranging between one thousand to five thousands feddans per scheme.

The budget analysis results indicated that the cost of production was higher in southern Gadarif than that in northern Gadarif due to higher rainfall and infestation with pests and weeds. Buda was the most dominant weed.

Accordingly the gross marginal revenue was negative across the total area of sorghum production in southern Gadarif contrary to that of northern Gadarif.

The results of the multiple regression analysis indicated the existence of positive and significant relationship between sorghum production and

sorghum cultivated area, and negative relationship with rainfall and deterioration of soil fertility. Also the results indicated a negative and significant relationship between the supply of sorghum to Gadarif crop markets, fees on crop and high cost of transportation. The study recommended to cultivate sorghum in recommended areas, use of improved seeds, conservation of environment by imposing planting of 5% of the area by forest trees inside the agricultural schemes and encourage the raising of livestock to reduce crop losses during drought periods.

خلاصة الأطروحة

إجريت هذه الدراسة فى ولاية القضارف وتتميز المنطقة بالمناخ المناسب لإنتاج المحاصيل المطرية [الذرة والسمسم].

وهدفت الدراسة لتقيم تأثير العوامل الاقصادية والاجتماعية المختلفة على اقتصاديات إنتاج محصول الذرة فى المنطقة.

لتحقيق هذه الأهداف استخدمت طريقة الانحدار المتعدد [Multiple regression] والتى تربط إنتاج المحصول بعوامل الانتاج. استخدمت ايضاً الميزانية المزرعية والاحصائيات الجدولية والوصفية. كل هذه البيانات طبقت على المعلومات الثانوية ذات الصلة بالدراسة والاولية التى جمعت من خلال المسح الميدانى فى ولاية القضارف [مناطق شمال وجنوب القضارف] أثناء موسم 2005/2004 بنظام استعمال الاختيار العشوائى الطبقى لاختيار اثنان وخمسين مزارع يمثلون حجم العينة.

أوضحت التحاليل الاحصائية للخصائص الاجتماعية والاقتصادية أن مزارعى القضارف الغالبية العظمة منهم مزارعين من الفئات العمرية المنتجة وحاصلون على مستويات تعليمية وصلت حد المراحل الثانوية والجامعية ويديرون مشروعاتهم الزراعية فى حيازات تراوحت بين ألف الى خمس ألف فدان للمشروع.

دلت نتائج الميزانية المزرعية على ارتفاع تكاليف الانتاج بجنوب القضارف مقارنة بشمال القضارف وذلك لارتفاع معدلات الامطار على قلتها فى خلال هذا الموسم والاصابة بالآفات والحشائش وأهمها البوده. وعليه فان هامش الربح على مستوى كل المشروعات بجنوب القضارف كان سالباً عكس حال مشروعات شمال القضارف.

دلت نتائج التحليل الارتدادى على وجود علاقة ايجابية ومعنوية بين مستوى الانتاج ومستوى المساحات المزروعة فى كل من المنطقتين وأن الانتاج يتأثر سلباً بتوفر هطول الامطار ومستويات الخصوبة للتربة. كذلك وضحت نتائج التحليل الارتدادى على وجود علاقة سلبية ومعنوية بين امدادات الذرة الى أسواق محاصيل القضارف وارتفاع تكاليف الترحيل والرسوم على المحصول.

وخرجت الدراسة بعدة توصيات أهمها الزراعة فى المناطق الموصى بها ، استخدام البذور المحسنة ، المحافظة على البيئة باستزارع الغابات داخل المشروعات الزراعية وتشجيع تربية الماشية لتقليل الفاقد من المحصول خلال فترات الجفاف.

Chapter One

Introduction

1.1. Agriculture in the Sudan:

The area of Sudan is about 2.5 million square kilometers (Tothill, 1947). The arable land is estimated to be around 217 million feddans. The area cultivated increased horizontally with fluctuations during the 1990s between 30-40 million feddans depending on the rainfall. The farming systems of Sudan are:

1.1.1. Irrigated sector:

This includes irrigation by gravity in central Sudan, by pumps along the main Nile, white and blue Niles and by floods in northern and eastern states, by underground water in other parts of the country. About 80% of irrigated area lies under the public sector in Gezira, Rahad, New Halfa, White Nile, Blue Nile and Suki agricultural large schemes, where crop produces cultivate the land on tenancy basis.

This sector uses farm machinery, fertilizers, herbicides, pesticides and improved seeds. This sector produces 100% of sugar came and wheat, 90% of cotton, 50% of groundnut, 24% of sorghum and 30% of sunflower, in addition to fruits, vegetables and green fodder all the year round in the Sudan.

1.1.2. Traditional rainfed farming sector:

The area under the traditional farming system ranged between 12-16 million feddans depending on rainfall. This sector produces about 95% of

millet, 50% of groundnut, 47% of sesame, 11% of sorghum and 100% of gum Arabic, most of Rosette (karkadeh) and melon seeds. Hand tools are used for land preparation, weeding and harvesting. In this sector farmers have no access to production inputs such as fertilizers, pesticides and good quality seeds, because of their low income and their scattered remote locations.

1.1.3. Mechanized Rainfed farming sector:

The mechanized rainfed farming sector uses about 17 – 20 million feddans to produce 65% of sorghum, 53% of sesame, 70% of sunflower and 5% of millet production in the country. Farm machinery is extensively used in most production operations. The mechanized farming is situated in the rain isohyets of 600 -800 mm. (Ali, 1999) (Khalil 2000).

1.2. Problem of the study:

Sorghum is the main staple food for most of Sudanese people in the urban and rural areas. Gadarif is the largest producing area of sorghum in the Sudan. The main problem that faces sorghum production in Gadarif area is the decline in productivity caused by fluctuating and declining rain fall, lack of use of improved seed as recommended by Agricultural Research Corporation for each location (Table1.1), spread of weed particularly high infestation of Buda, infestation of pest, and disease, low soil fertility, inadequate crdite and lack of crop rotation and other technical packages. This would lead to high cost of production and low income levels.

The problem of the study is to investigate the impact of all the above factors affecting sorghum crop production in the Gadarif area.

Table 1.1 Sorghum area and recommended variety according to rainfall distribution in Sudan

Average rainfall distribution in m/annum	Total area (000 feddans)	Sorghum area (000 feddans)	Sorghum area (%)	Recommended variety
900-600 mm	3095	1392.750	45%	Wad Ahmed, Gadam hamam,Tabat, Millo, Arafa,Tetron, Dabar
600-500mm	720	432	60%	Abedala Mustafa, Sifera, Mugud, Ombanin, Faky mostahi and Agab sido
500-400mm	225	200-220	80-90%	Arfagadamk, Gadamblia flower, Korkolo
>400mm	6315	4074.750	-	These are grazing pastures and no crops are recommended. Instead can distribute pasture seeds.

State Ministry of Agriculture -Gadarif State

1.3. Objectives of the study:

1.3.1The main objective of the study:

The main objective of the study is to identify the main factors affecting sorghum production in Gadarif area.

1.3.2. The specific objectives of the study:

1- To determine the socio-economic characteristics that influence the production of sorghum in Gadarif area.

2- To estimate the annual farm income of sorghum in Gadarif area.

3-To identify the relationship between sorghum production and the respective factors of production.

1.4. Hypotheses of the study:

1- Socio-economic factors have strong influence on sorghum crop production decision making.

2- Gross marginal revenue is positive for sorghum crop producers in Gadarif area.

3- Horizontal expansion over land is the major determinant factor of sorghum output level.

1.5. Research methodology:

1.5.1. Area of the study: Gadarif area (northern and southern areas).

1.5.2. Time of the survey: Season 2004/2005

1.5.3. Methods of data collection:

1.5.3.1. Data source:

Both primary and secondary data were collected from relevant sources.

1.5.3.2 Sample technique:

For the survey purpose multi-stage random sampling was used to select the respondents.

1.5.3.3. Sample size:

The sample size was determined according to the availability of finance, time and other considerations. The study interviewed 52 respondents, about 4% of total farmers in northern and southern parts of Gadarif area, the main study area.

1.5.4. Methods of analysis:

The analytical methods used:

Descriptive statistics.

Budget analyses.

Multiple regression models

1.6. Organization of the study:

The study consisted of five chapters:

Chapter one: gave the introduction, it describes briefly the problem statement, the objective of the study, hypotheses and organization of the study.

Chapter two: gave the literature review.

Chapter three: gave the methodology.

Chapter four: gave the result and discussion.

Chapter five: gave the summary, conclusions and recommendations.

Chapter Two

Literature Review

2.1. Importance of sorghum as the main staple food crop in Sudan and other countries of the world:

Sorghum is the main food grain crop in Sudan, which is produced in irrigated and rainfed mechanized and traditional sub sectors (Osman, 1996). It is also an important food crop in many African and Asian countries. In the USA most of the sorghum grain is used as livestock feed. There is, nonetheless, a potential export market for sorghum as food and feed. For food use, the grain is roughly grounded and made into bread-like flakes or loafs. Sometimes sorghum is mixed with wheat flour for bread making. The grain is also a source of native beers, particularly in Africa (Smith, 1990).

2.2. Crop productivity in Sudan compared to other countries of the world:

Sorghum crop productivity records in Sudan are low compared to the world standards (Ahmed, unpublished) (Solun, 1989). (table 2.1).

Table 2.1: Comparative data for five commercially grown crops in Sudan and elsewhere, 1988 (average yield in kg /ha)

Region/crop	Sorghum	Wheat	Millet	Sesame	Groundnut
Sudan	789	1257	239	240	858
Africa	870	1682	757	307	806
World	1355	2314	776	336	1165
N. America	3496	1942	NA	592	2788
Europe	3825	4586	1906	610	1788
Asia	958	2263	764	337	1222

Source: Fata and future of seed industry in the Sudan

NA: not available

2.3. Importance of improved seed:

Increasing production particularly for food crops is the main reason for using improved seeds. The use of seeds that don't meet the specifications of improved seeds causes the following:

1- Decrease in crop productivity.

2- Weakness of plant intensity.

3- Increase in the spread out of diseases and appearance of new diseases.

The use of improved seeds leads to increase in production and therefore leads to positive effects:

1- Achieve food security:

In spite of Gadarif area had an important strategic position in sorghum crop production (the first crop in the Sudan), then the use of improved seed for this crop is a crucial factor for national interest.

2- Decrease production cost:

Increase of productivity leads to a decrease in cost of production

3- Share in rural development:

Production, processing and use of improved seed and supply of inputs and other services require development of the basic infrastructure that leads to positive response in rural development in this area.

4- Export development:

It is known that the increase of production requires the sale of the surplus production. It is assumed that the output of crops using improved seeds can meet the approximate quality requirements of export crops

including purity and uniformity aspects according to the recommendations of export conference. The use of improved seeds is a basic condition for export of specified crops. Elahmmady, (2002).

2.4. The performance of sorghum production in Sudan during 1995-2000 and the Strategy for 2002-2027:

It was indicated that the average total annual sorghum area in the irrigated sector was about 6.3% of total area of Sudan during 1995/1996-1999/2000), and was about 61% in mechanized rain fall sector and 33% in traditional rainfall. The average percentage of total production was 20% in irrigated sector, 53% in mechanized rainfall sector and 27% in traditional rainfall sector. The average productivity percentage was 313%, 87%, 82% of all Sudan productivity for irrigation, mechanized and traditional sectors respectively.

From above it appears that the mechanized rainfed sector was one of the most important sectors particularly in Gadarif area in the sorghum national economy and food security during the strategy of 2002-2027 (table 2.2) (fig. 2.1) and (fig. 2.2).

Table 2.2 The contribution of Gadarif State, in area and production of sorghum (1995/96-1999/2000)

(Area in 000 feddans) (Production in000 tons)

Year	Sudan total area	Gadarif State area	%	Sudan total production	Gadarif State production	%
1995/96	12007	3496	29	2450	619	25
1996/97	15602	5367	34	4179	1251	29
1997/98	12646	3380	26	2870	599	20
1998/99	15024	4579	30	4274	1254	29
1999/2000	10780	2954	27	2347	358	15

Source: Strategic 2002-2027

Fig. 2.1 Sorghum crop area in Sudan and Gadarif mechanized rainfed schemes 1995-2000.

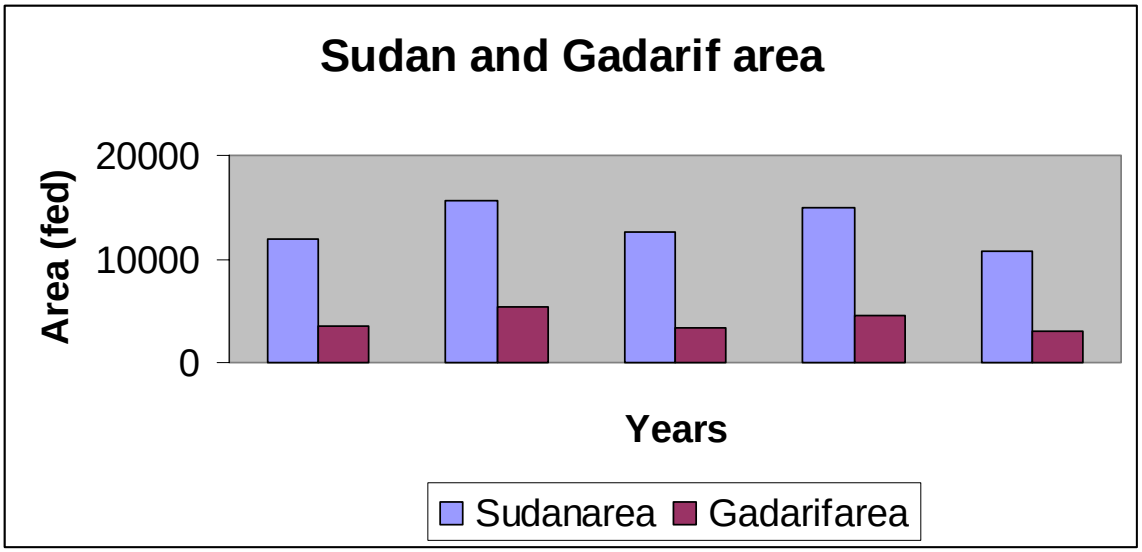
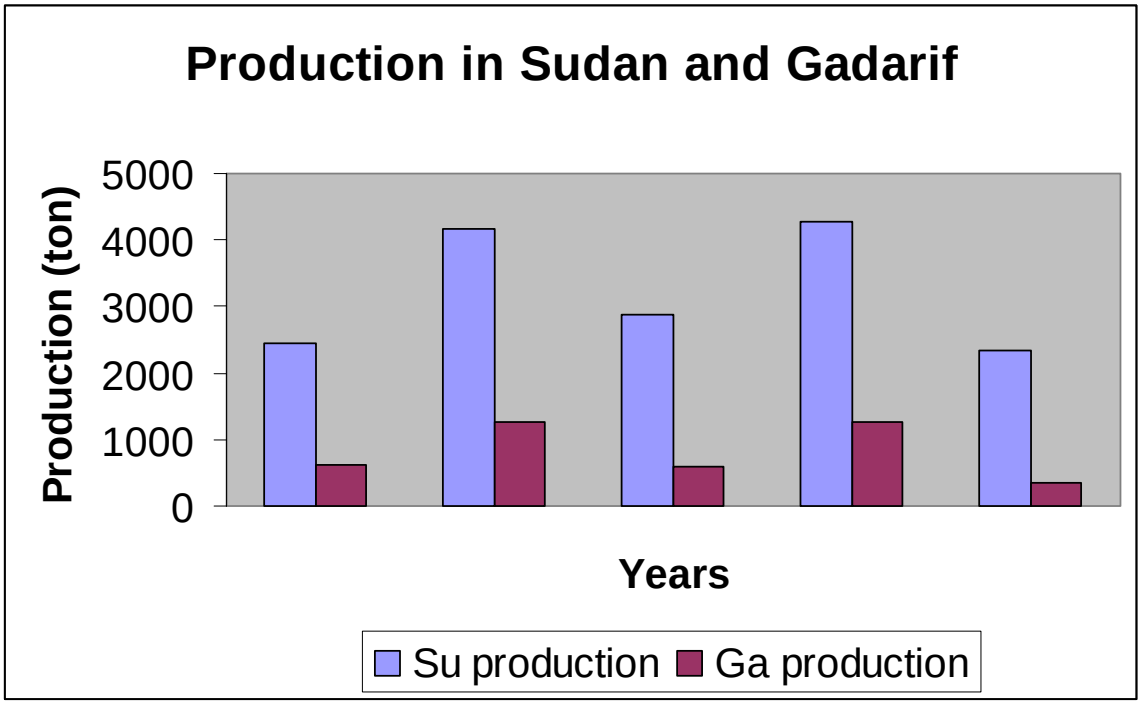


Fig. 2.2 Sorghum crop production in Sudan and Gadarif mechanized rainfed schemes 1995-2000.



2.5. Sorghum:

2.5.1. Background:

Sorghum, the fifth most important cereal crop in the world, belongs to the family Poaceae. Sorghum bicolor (L.) Moench contains both the cultivated and wild species of sorghum. Sorghum is the leading cereal grain in Africa and is also important in India, China, Australia, various countries in Latin America and in the United State. (fig. 2.3).

Grain sorghum competes today in many new and exciting markets. While there are literally thousands of potential uses for this diverse grain, the focus is on food, fuel and feed. (USDA/FAS, 2001)

2.5.2. Sorghum environmental requirement:

2.5.2.1. Water: Sorghum can successfully grow under rainfall ranging between 400-800 mm annually. This range is easily found in Gadarif area.

2.5.2.2. Soils: sorghum can be grown in sandy (qoz) to heavy clays. Sorghum can tolerate saline and alkaline soils. However, high salinity reduces the level of crop yields.

2.5.2.3. Temperature: The appropriate temperature for sorghum production falls within the range of 26-30 degrees centigrade. It requires dry weather and can tolerate high temperature. However, high temperature affects sorghum crop yield, particularly during sowing date.

2.5.2.4. Sowing date: The optimum sowing date for sorghum lies within July and early August.(ARC,2003).

2.5.3. Sorghum pests:

Weeds infestation is the main factor behind the reduction of crop production by about 25%-60%. Buda: is the main problem in sorghum crop production. It is controlled by crop rotation and use of resistant varieties such as Mugawim buda 1, Mogawim buda 2.

Sorghum diseases covered smuts and losse smut. They are treated with chemical control

Insects include Aphids, stem borer, American boll warm. They are to controlled by early cultivation. El Obeid, (1997).

2.5.4. Sorghum varieties:

Table 2.3 :The important sorghum traditional varieties in Sudan

Area	Cultivation requirements	Sorghum varieties
East and central Sudan	More than 600 mm rainfall	Dabar baladi, Iriana, Ras al girid
East and central Sudan	400-600 mm	Arfa Gadamak, Korakolo, Agab Sido, Abdalla Mustafa, Geshias
Darfur	Wadies	Faseikh, barbari
North Kordofan	400-600 mm	Agab El rigal, Al Zaawi
Nuba mountains	More than 500 mm	Kurmuka
Gash	Flood irrigation	Aklamoya
Northern Sudan	Irrigation	Debaikri, Gassabi, El Ab Garo, Dora Al Sabi, Sin Al Sabaia
Central Sudan	Irrigation	Wazn Ashara, Wad Fahal, Mayo, Wad Marghani, El Hemisy

Source: Seed Administration, Khartoum, Sudan.

2.5.5. Uses of sorghum in world:

Can be used as unleavened breads, boiled porridge, malted beverages, popped grains and syrup from sweet sorghum. The sorghum flour can be mixed with wheat flour for bread making. The stem of sorghum can be used for building, fuel, making baskets and fish traps. (Magness et al, 1971).

2.5.6. Uses of sorghum in Sudan:

Sorghum is used as Kisra and porridge (asida).

2.6. Sorghum research programs:

Sorghum average area in the rainfed sector is estimated at 12 million feddans, while only one million feddans are cultivated in irrigated areas. To promote sorghum production, it is necessary to raise present levels of productivity that are around 0.2 tons per feddans in the rain-fed areas and 0.5 tons in irrigated schemes. These figures are indicative of a very low productivity compared with the existing potential. Over past 10 years, research program has successfully bred improved sorghum varieties characterized by high yield and good quality, to be grown in irrigated schemes. Five of these varieties have been released. Their average production in farmer's field was around 1.35 tons per feddan, while one of these, variety "Tabat", has scored as high as 2.3 tons per feddan in research stations.

This program aimed at:

(1) Raising productivity,

(2) Breeding for high grain quality,

(3) Breeding open –pollinated varieties and hybrids that have high yield and quality of optimal maturity, adaptable to different production environments in order to meet local and international market demand (ARC, 2004).

2.7. Seed industry in Sudan:

Seed industry in Sudan in one form or another, dates back to the1950s', which evolved through the following phases:

(1) Research propagation unit :

This unit was developed in 1950s to multiply seeds. It included breeding of new varieties seeds and multiplying them.

(2) Ministry of Agriculture :

In 1968 the Ministry of Agriculture became responsible for seed industry in the Sudan. The administration was responsible for new propagation of improved seeds began its activities on cereals and oil seeds such as sesames and groundnuts and on some vegetable crops.

(3) The private sector:

The private sector began its seed industry activities in 1980 on limited scale. Pioneer of the USA was a successful example in this respect.

(4) The Large irrigated schemes:

The contribution of large irrigated schemes to seed industry in the Sudan was recognized. The major irrigated scheme in Sudan particularly the Gezira scheme was actively involved in the propagation and multiplication of improved seeds of cotton, wheat, sorghum.

The Gezira scheme had close cooperation with the agricultural research corporation in this regard.

(5) The role of the ministry of agriculture:

By the 1990 the role of the Ministry of Agriculture in seed industry began to change. The National Seed Administration of the Ministry of Agriculture had two branches:

- The seed certification.
- The propagation and multiplication branch.

The seed certification branch was mainly responsible for the seed quality control. This function was further developed toward the late 1950s in seed inspection and certification role.

(6)The privatization of the seed industry in the Sudan:

Guided by the privatization policy, the seed industry in Sudan was transferred from the public sector into the private sector. This became effective through the establishment of the joint venture ‘Sudan Arab seed Company (ASSCO) ‘between the government of Sudan and AAAID. In this venture Sudan provided land and seed infrastructure, while the AAAID provided funds. The joint venture is expected to provide improved seed that covers the demand of the different agriculture farming system of Sudan in the irrigated and rain- fed sectors. (Salih 2003).

2.8. The present seed propagation organization structure in Sudan:

(1) The Agricultural Research Corporation:

To breed for hybrid seeds and selected improved are to release new tested varieties recommended by the new technical committee for variety

release (TCVR). The Amended seed law of 1990 mandates that TCVR has to establish the distinction, uniformity and stability of new varieties for approval and release for further multiplication and use

(2) The seed administration (SA):

To carry out field inspection and issue verifying certificates of the quality of inspected and tested seed according to seed law and refutation.

(3) Seed unit of the irrigated agricultural schemes:

Propagate about 80 to 90 percent of improved and hybrid seeds of cotton, wheat and about 3 percent of improved seeds of groundnuts crop verities.

These seed schemes are produced on farms or in contract with selected tenants.

(4) Private companies:

ASSCO and other small private companies and seed marketing agents supply seeds to many areas in traditional sector. (table2.4) (ASSCO Annual Report).

(5) Crop producers:

Crop producer keep about 80 percent of their needs of sorghum, sesame, groundnuts seed. (Salih, 2003).

Table 2.4 Quantity of certified seeds production by seed companies for the season 2002/2003

	Sorghum		**Groundnuts**		**Sesame**		**Millet**		**Maize**	
Company	Quantity (ton**)**	% Share	Quantity (ton**)**	%Share	Quantity (ton)	%Share	Quantity (ton)	%Share	Quantity (ton)	%Share
ASSCO	3129	56.8	933	77.3	43.85	56.3	13.5	**12.8**	**15**	**15.50**
Zass	1043	18.9	271	22.5	34.00	433.7	90.9	86.5	10	10.30
Agri-business	171	3.1	-	-	-	-	-	-	72	74.20
Foknab	1170	21.2	-	-	-	-	-	-	-	-
Total	5513	100.0	1206	100.0	77.85	100.0	103.5	100.3	97	100.0

Source: ASSCO's Records, 2003.

2.9. Seed marketing:

According to Mumby (1994), seed marketing means to deliver good quality seeds to farmers at an acceptable price. Seed production received more attention and storage than managing sales and distribution of seeds.

Seed marketing to the retailer in agriculture sector means selling seed along with other inputs to the farmer. People think of marketing in term of advertising and selling of goods, whereas in reality marketing starts long before the goods exist and continues long after they are sold. Therefore, the marketing process requires that:

- The farmer consumer's needs must be satisfied.
- The seed company's objective must be realized.

2.10. Relationship between seed marketing and the general agricultural marketing:

In order to guarantee the effectiveness of certified seeds in increasing crop yields, additional complementary technical packages are needed. In this context, any proposed seed enterprise has to take into consideration the existing seed production, marketing and organization systems. They are to be supplied with additional inputs that would facilitate better usage of the certified seed. The package of inputs can be delineated in light of the existing farming systems and organizations of the local economy and the environment in which the new seed enter price has to perform. (Salih, 2003).

2.11. Demand for seed:

2.11.1. Sudan's demand for improved seeds:

The information and data on demand for improved seed of crops for the country is meager:

(A) Awareness and adoption of improved seed is very low among most of the farmers,

(B) Adoption rate of improved varieties in irrigated sector is high whereas the mechanized sector prefers those varieties accepted in the international grain market,

(C) Estimation of seed demand is based on the areas expected to be cultivated annually regardless of the seed multiplication factor and mode of pollination, which determine the period for the farmer to renew his seeds.

In the light of the above information, the seed requirements that meet country demand for improved seeds for both irrigated and rainfed sectors can be extrapolated (table 2.5). The seed gap is the difference between the demand and the supply for a certain period (AAAID, 1995).

Table 2.5 Actual and projected demand, supply and gap of improved seeds for (1996-2001) (in tons):

Seed crop	1996	1997	1998	1999	2000	2001
Wheat:						
Demand	26235	30170	34696	39900	45885	52763
Supply	1243	3273	3333	3280	4009	4009
Gap	24992	27797	31363	36620	41876	48754
Sorghum						
Demand	20988	24136	27757	31920	36906	42215
Supply	2390	3321	4091	4577	4577	4577
Gap	18598	20815	23666	27343	32330	37638
Groundnuts						
Demand	30608	35199	40479	46550	52523	61562
Supply	1256	1742	1944	1944	1944	1944
Gap	29352	33457	38535	44606	50576	59619
Sunflower						
Demand	4198	4827	5551	6384	7342	8443
Supply	32	255	608	972	972	972
Gap	4166	4572	4943	5412	6370	7471
Maize						
Demand	1662	2027	2473	3017	3680	4491
Supply	81	194	366	810	810	810
Gap	1581	1833	2108	2207	2870	3681
Vegetables						
Demand	4198	4827	5551	6384	7342	8443
Supply	1	49	73	81	81	81
Gap	4197	4778	5478	630	7261	8362

Source: AAAID (1995) feasibility study for establishing a seed company.

Notes on the table:

1- Seeds kept by crop producers from previous season commercial crop.

2- Seeds acquired from neighbors or from a local market,

3- Seeds obtained from famous crop producers who select and produce good local seed varieties or improved varieties,

4- Certified seeds obtained from government, NGOS, organizations, markets,

5- Seed imports.

2.12. Supply of seeds:

The table 2.6 below gives the amount of sorghum seed production in COMESA and the Arab countries. The table indicated the continued increases in seeds and the potential for use of improved seeds that can increase the crop yield in those countries (FAO, 2003).

Table 2.6 sorghum seeds production in COMESA and Arab countries, 1992-2002 (tons)

Country	Year										
	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
COMESA	76,956	113,484	94,702	106,805	115,250	100,524	103,882	92,905	117,191	135,876	154,828
Burundi	1,160	900	1,000	1,000	1,100	1,080	1,000	1,000	1,100	1,110	1,110
Central African Republic	684	1,047	1,198	1,307	1,320	1,320	1,880	1,920	2,000	2,120	2,120
Chad	7,437	9220	10,128	8,760	11,032	10,676	9,671	9,765	11,842	9,975	9,975
Congo	1,925	1,925	1,971	1,906	2,016	2,079	2,144	2,125	2,225	2,225	2,225
Egypt	4,400	4,700	4,400	4,200	4,500	4,519	5,757	5,000	4,438	4,160	4,160
Eritrea		2,620	2,601	2,000	2,400	4,725	2,362	2,364	1,464	1,658	1,663
Ethiopia	2,200	15,080	18,397	26,632	28,868	19,634	21,388	20,223	26,954	27,800	27,800
Iraq	89	92	92	92	94	96	98	96	98	98	98
Kenya	2,404	2,400	2,000	2,600	2,800	2,800	2,827	2,450	2,722	2,800	2,800
Lebanon	26	22	23	20	20	20	13	21	22	22	22
Madagascar	40	40	40	40	40	40	40	40	40	40	40

Malawi	658	817	924	1,140	1,258	1,019	890	825	811	816	210
Mauritania	3,126	5,100	4,929	4,226	2,833	3,120	3,400	3,800	3,600	1,376	1,376
Morocco	550	584	584	726	450	636	604	322	336	340	340
Namibia	600	970	580	736	508	396	376	440	424	424	424
Rwanda	2,000	1,600	1,342	1,500	2,178	2,293	2,585	3,484	3,709	3,436	3,436
Saudi Arabia	3,566	3,957	4,427	4,499	4,469	4,412	3,807	3,885	4,410	4,410	4,410
Somalia	5,600	12,424	8,000	9,000	10,000	5,400	8,000	9,000	8,000	8,000	8,000
Sudan	50,000	70,700	50,000	52,060	56,500	50,000	52,506	43,120	62,734	80,447	100,000
Swaziland	14	26	40	28	21	20	20	20	20	20	20
Syria	143	114	92	136	95	93	77	70	74	72	72
Tunisia	100	80	60	60	60	60	60	60	60	60	60
Uganda	7,650	7,800	7,980	8,130	8,280	8,400	8,250	8,400	8,460	8,400	8,400
Yemen	11,420	11,211	11,210	10,664	10,741	11,457	9,188	8,991	9,483	10,000	10,000
Zambia	931	1,105	807	957	894	717	733	786	436	440	440
Zimbabwe	2,974	3,501	2,620	3,876	3,887	2,802	3,004	2,628	1,654	2,100	2,100

Source: FAO Statistics, 2003.

2.13 Contribution of the mechanized sub sector to GDP:

Over the period 1989/90-1990/99 the contribution of the agricultural sector to GDP ranged between 30.1 to 48.4 but the contribution of the mechanized sub sector to GDP ranged between 1.5% to 4.6% (table 2.7) (Abu Adil, 2004).

Table no 2.7 the contribution of agriculture and mechanized rain fed sector to GDP of Sudan (1989/90-19998/99) in percentages

	1989/90	**90/91**	**91/92**	**92/93**	**93/94**	**94/95**	**95/96**	**96/97**	**97/98**	**98/99**
Agricultural Sector	30.1	28.6	30.0	38.0	40.0	43.1	43.0	45.0	47.4	48.4
Mechanized Rain fed	3.0	1.5	4.3	4.6	2.3	2.8	2.7	2.2	3.2	1.9
Traditional Rain fed	3.1	1.8	14.4	3.9	4.1	6.7	6.7	6.0	6.9	1.4
Total Rain fed	6.1	3.3	18.7	8.5	6.4	9.5	9.4	8.2	10.1	3.3

Source: Annual reports of Bank of Sudan.

2.14. The economic importance of mechanized rain fed sectors:

The mechanized rain fed sector contributes considerably to the role of agriculture in the country's economy in the two main crops, sorghum and sesame. This importance of the mechanized rain fed sector is also

reflected in the government development policies and plans, the donors projects directed towards it was the magnitude of credit received from the Agricultural Bank of Sudan (ABS).

The contribution of the sub sector to crop production:

The mechanized sub sector produces the two main crops, sorghum and sesame. Other minor crops are millet, cotton and sunflower. The mechanized rainfed sub sector contributes 68% of the countries production of sorghum (table 2.8). (AbuAdil, 2004)

Table No 2.8 The contribution of the mechanized rain fed sub sector to total sorghum and sesame 1989/1990-2000/2001

Season	Total production (000 tons)		Mechanized (000 tons)		Mechanized sector (%)	
	Sesame	Sorghum	Sesame	Sorghum	Sesame	Sorghum
1989/90	140	1596	75	1144	54	72
1990/91	81	1180	66	664	81	56
1991/92	97	3581	85	2695	88	72
1992/93	266	4042	204	3273	77	81
1993/94	175	2386	93	1784	53	75
1994/95	170	6348	105	2922	62	46
1995/96	13	2450	263	1937	48	79
1996/97	419	4179	308	2291	74	55
1997/98	281	2870	216	2192	77	76
1998/99	225	4284	150	3620	67	85
1999/2000	329	2347	242	1322	74	56
2000/2001	282	2488	225	1583	80	64
Average	232	3146	169	2119	73%	68%

Source: Agricultural situation and out look annual reports.

Ministry of Agriculture and Natural resource.

2.15 Cost of production of Sorghum :

The main items of cost of production of sorghum were cultivation and harvesting operation according to over 40% and over 30% on average for both items respectively. (table 2.9).

With in cultivation process, weeding was found to be the most costy item. (table 2.10).

Table 2.9 Average cost of production of sorghum in Gadarif area for selected season 1992/93-2001/02

Item	**92/93**	**%**	**96/97**	**%**	**98/99**	**%**	**2001/2002**	**%**
Land Preparation	762.3	15.4%	1641	4.4%	3723.6	6.7%	10500	18%
Cultivation	1542.3	31.1%	17940	47.8%	26458.3	47.7%	20450	35%
Harvesting	2100	42.3%	10692	28.5%	17207.5	31%	15200	26%
Input	554	11.2%	7249	19.3%	8061	14.6%	12350	21%
Total	4958.6	100%	37522	100%	55450	100%	58500	100%

Source: appendix (1)

Table 2.10 Average cost of cultivation activities for sorghum in Gadarif area for selected season 1992/93-2001/2002

Item	92/93	%	96/97	%	98/99	%	2001/2002	%
Cultivation	542.3	35%	1374	8%	3456.6	13%	8450	41%
Weed	1000	65%	5218.03	29%	11617.7	44%	12000	59%
Other	-	-	11348	63%	11384	34%	-	-
Total	1542.3	100%	17940.03	100%	26458.3	100%	20450	100%

Source: appendix (1).

Chapter Three

The Methodology

3.1. Introduction:

This chapter gives an insight on the theory of economic production and the methodology used for data collection and analyses conducted.

3.2. Methodology:

This study depended on two sources of data:

3.3. Primary data: Survey and questionnaire

The primary data were collected through a field survey involving the use of structured questionnaire covering information on age, educational level, family size, marital status, agriculture area, land tenure, variety used, soil fertility, type of seed, rate of cultivated, access to seed, experience and storage.

The field survey was conducted during the season of 2004/2005.

3.4. Secondary data:

The secondary data were collected from reports, files, previous studies, papers and other material from official sources, which included the Ministry of Agriculture and Forestry, Department of Agricultural Economics and Statistics of the Ministry of Agriculture, Gadarif Mechanized Farming Corporation, Arab Sudanese Seed Company (ASSCO), Gadarif management markets of crop, Agricultural Bank of Sudan (ABS), Food and Agriculture Organization (FAO) and Seed Admiration.

3.5. Size of Sample:

The sample size chosen was a trade-off between the level of precision aimed at and the resources available in terms of time, cost and other facilities (Sampford, 1962).

The sample of 52 farmers was selected from 2 areas, south and north of Gadarif State. This sample accounted to about 4 % of the total farmers in north and south Gadarif State.

3.6. Random sample:

Respondents were randomly chosen from the two areas.

3.7. Method of analyses:

3.7.1. Descriptive analysis:

Using percentages, frequencies and means.

3.7.2. Gross marginal analysis:

Gross marginal values (GMVs) per unit of crop and head of livestock are widely used for comparative analyses of activities on one farm, and between farms in similar environments. It is also a useful first step in deciding on the best combination of activities on the farm. The procedure here is to select the highest GMVs per unit of the most common limiting resource (land, capital, rotation and man-hours). (J.P. and L.R., 1985).

Calculation of GMVs is simple and direct technique, useful in farm budgeting and planning. GMVs are the differences between gross returns and the total variable cost.

GMVs = Gross return –Total variable cost.

3.7.3. Regression analyses:

This procedure is used to assess the relationship between the dependent variable and the independent variables that affect it:

3.7.3.1. Multiple Regressions:

The multiple regression analyses were used.

In the multiple regression analysis there is more than one independent variable that affects the dependent variable (Kennedy, 1985). It measures the effect of change in one variable while holding other variables constant.

The general equation of multiple regression models is written as:

$$Y = bo + b1 + \ldots..+bn\ xn + e$$

Where:

Y =the dependent variable.

X1…Xn =the independent variables.

Bo =intercept.

B1…bn =regression Coefficients.

e =the error term..

The coefficients represent the change in the value of the dependent variable for a unit change in one independent variable, assuming other independent variables being constant.

3.8. The coefficient of the multiple determinations (R square):

It gives the percentage of the variation in the dependent variable explained linearly by the variation in the independent variables.

R – Square ranges from zero (no linear association) to one (an exact linear association).

The adjusted R square is developed to facilitate meaningful comparison across equations using different explanatory variables and different sample sizes. It is always less than the unadjusted R.

3.9. The test of hypotheses:

i. The t –test:

T – Test is related to individual coefficient in the regression model. It is used to test weather each coefficient is significantly different from zero or not.

T values are calculated by dividing the regression coefficient of the variable by its standard error. The computer software regression package gives the t – value to the probability of this coefficient being significantly different from zero.

ii. The F –test:

F – Test is the same as t – test, but rather than testing the individual coefficient it tests: whole regression model weather the equation holds or not. The null hypotheses here assume that all regression coefficients are simultaneously equal to zero, alternative hypotheses assume that at least one of the coefficients is significantly different from zero.

F – Values are calculated as follows:

$F = [(RSS/K)/ESS/(n-(k+1)]$

Where:

RSS=Regression sum of square.

ESS= Error sum of square.

K = Numbers of independent variable.

K –1= Number of independent coefficients.

n = Number of observation.

3.10. Area of the study: (Gadarif area)

3.10.1. Background:

The Gadarif state has been an economically important area in Sudan since the 1940s. It is located in the southern part of Kassla State in Eastern Sudan. It lies southeast of Khartoum (400 Km) and (700 Km north – east) from Port Sudan on the Red Sea. It lies next to major tributaries of the Blue Nile, the Rahad River and Atbra River. The State is about 600 meters above the sea level. Gadarif has a large grain and animal market (Ismail 2000) (In Arabic).

It has relatively fertile soils and moderate to sufficient rains, so that the government of Sudan has developed large mechanized agricultural schemes in Gadarif area. This state has been a rich source of animals supply composed of cattle, camels, sheep and goats.

From an agricultural point of view, Gadarif state offers good conditions for agricultural production. Gadarif state was selected as a study site because it is important to Sudan's economy. (El tayeb, 1985).

3.10.2. Climate:

The Gadarif area is part of the central clay plain, and lies in the southern part of Butana clay plains. (AbuAdil, 2004).

3.10.3. Rainfall:-

This area receives between 300 and 800 mm 0f rainfall of annually. The Gadarif area has a dry season for about eight months of the year. Most of the rainfalls between June and October and reaches it is peak in August. Planting, weeding and harvesting are all centered on these four to five months. Eventhough, the rainfall season extends over four to five months, rainfall intensity and distribution may vary within each and between these months. Such wide unpredicted variation in rainfall had its intense effects upon the level of crop yields and production areas.

Agricultural production is affected by seasonal fluctuation mainly due to the wide variation in the annual rainfall or the un- even distribution of rains during the rainy season. (Table 3.1) (fig. 3.1).

Table 3.1 Annual rainfall distribution in the study area in mm.

Year	Gadamblia	Doka	Omsyenat	Sumsum	Hawata	Gadarif
1992	730	746	801	829.5	455	574
1993	616	656	818	774	600	777.3
1994	619	696	1070	826	478	631
1995	463	656	694.6	792	645.2	521.6
1996	627.5	700	602.5	821	566.7	713.7
1997	452.5	645.7	705.5	788	678.5	528.5
1998	582.9	740.3	812.5	602.6	809	570.3
1999	531.5	800.3	724.9	884.5	789.7	871.3
2000	426.9	678.3	627.1	420.1	727.3	637.2
2001	490.9	578.3	721.5	757.7	536.2	476.5
2002	483	638	687.3	516.5	492.3	631.5
2003	588.3	711.8	535.5	460.9	546.8	756.8
2004	423.7	516.7	429.4	736	390.8	493.1

Source: Gadarif Mechanized Farming Corporation (GMC).

3.10.4. Temperature:-

The lowest temperature occurs during January (15c) and the highest on occurs in April, reaching 40c. The relative humidity range between varies between 24% in April and 73% in August. (El tayeb, 1985).

3.10.5. Soil:

The Gadarif soils are black to deep brown, with high clay contents and strong vitriolic characteristics. Most soils were formed from weathering products derived from basaltic rocks of the Gadarif Gallabat riding and basement complex rocks. Rain land clay plains crack deeply in the winter after kharief season and crumble during dry seasons. During the wet seasons they get spongy. As the result of their high permeability, little water is lost to run off. The Gadarif areas also contain stones of quartz on surface, widely spread, and are good for cultivation. These soils are called “Bashendi”. (AbuAdil, 2004).

Fig. 3.1 Rainfall distribution in Doka area in Gadarif state 1992-2004.

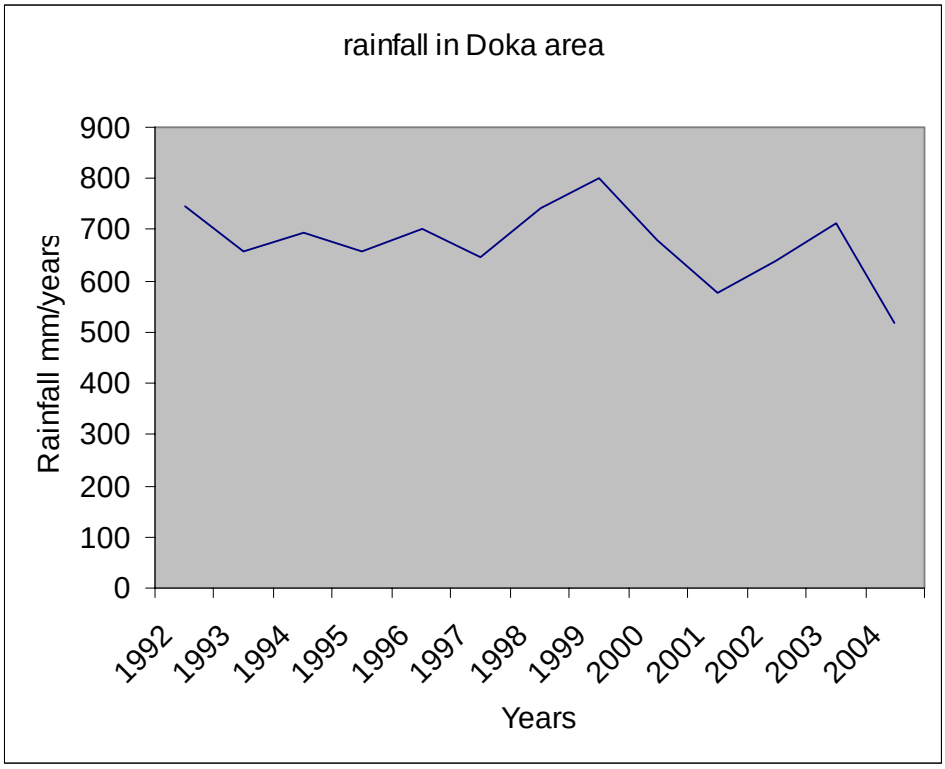


Fig. 3.2 Rainfall distribution in Um Syenat area in Gadarif state 1992-2004.

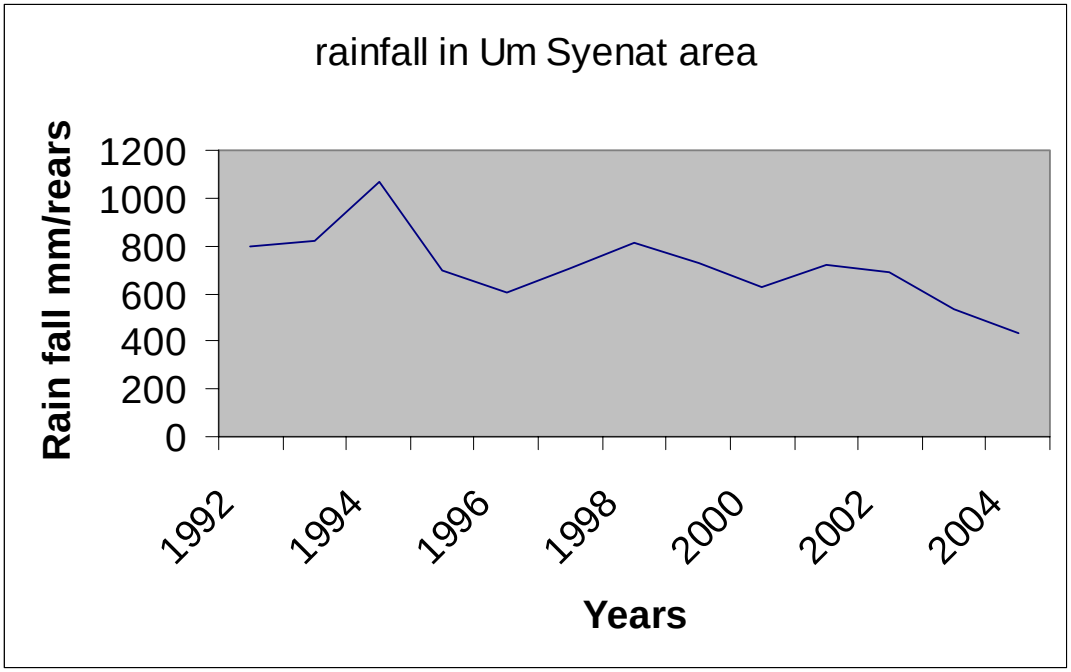


Fig. 3.3 Rainfall distribution in Hawata area in Gadarif state 1992-2004.

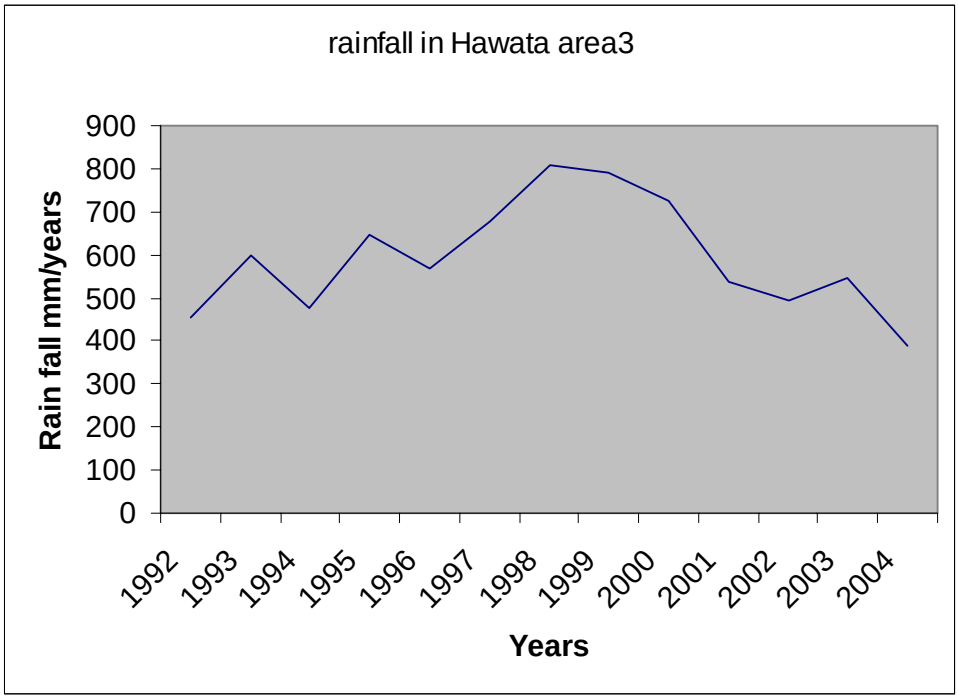
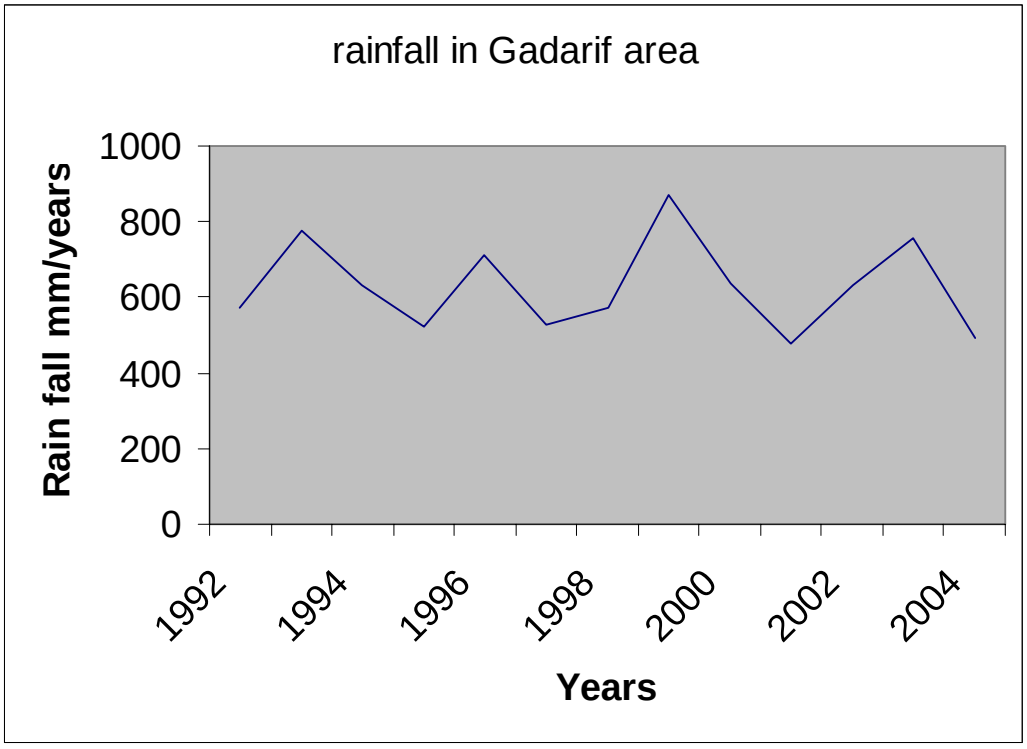


Fig. 3.4 Rainfall distribution in Gadarif area in Gadarif state 1992-2004.



Chapter Four

Results and Discussion

4.1. Introduction:

This chapter reviews the results and gives the discussion and implied interpretations of the results of the analyses as detected by the guiding objectives and hypotheses of the study.

4.2. Socio-economic characteristics

The socio economic characteristics of the producers are expected to have great effects on their production and may be help in explaining the variation in output among them. The effect may be negative or positive.

From the survey results it was observed that all the farmers surveyed were males.

4.2.1. Age and educational factors:

Most of farmers were from the age groups above 25 years old. About 75% of the respondents had secondary and university education. This high level of education may reflect the readiness to accept new technology and extension advice in agriculture production. They also can be trained in new management system. It is worth mentioning that agriculture services were absent in mechanized farming in Gadarif region.

Therefore, it is easy to interact with these farmers improving their production management and technology using improved seeds, fertilizer, pesticides and crop rotation that would help to increase their low crop yield level per feddans. The problem of low productivity in feddans is most important problem in mechanized farming in Gadarif region. It resulted in high cost of production, low income, which can not be overcome except by achieving high productivity for all agricultural crops, of which sorghum is an example.

On the level of total economics in the time of Galobalization.Sudan must continue the production and good quality of crops like sorghum, sugar came, cotton and sesame to increase their competitiveness in the international trade (table 4.1).

Table 4.1: Distribution of age and educational level in northern and southern Gadarif area:

Village	Age			Educational		
	<25	25-45	>45	Khalwa	Secondary	University
North of Gadarif	1.9%	23.1%	25%	13.5%	25%	11.3%
South of Gadarif	-	25%	25%	11.5%	23.1%	15.4%
Total	1.9%	48%	50%	25%	48.1%	26.9%

Source: filed survey 2004/05

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4.2.2. Family size and marital status:

Most of farmers surveyed, about 87%, were married. This indicates their ability to be responsible and how they can afford to pay family expenses, as they own large areas and have good income. We found that the size of families started to decrease as result of education, which led to social changes in concepts, traditions and costumes. Accordingly, there has been a change from large extended families into small families system, with family members not exceeding seven members.

The small families were independent and give their children more care and educate them until they reach maximum education level. In turn

this affects the consumption of food particularly of sorghum, which is largely produced in Gadarif region (table 4.2).

Table 4.2: Distribution of family size and marital in northern and southern Gadarif area:

Village	Family size		Marital		
	<7	7-9	>9	Married	Single
NGadarif	21.2%	19.2%	9.6%	46.2	3.8%
S Gadarif	26.9%	13.5%	9.6%	4o.4%	9.6%
Total	48.4%	32.7%	19.2%	86.6%	13.3%

Source: field survey 2004/05.

4.2.3. Agricultural area and land tenure:

About 60% of the respondents had land area ranging between one thousand feddans to a little bit more than five thousand feddans. About 27% had land area less than one thousand feddans. About 73% of the respondents owned land inherited from fathers and grandfathers. This land was purchased from the government on rent contract. We also found that there was a small percent of land, about 11%, rented from government and about 3.8% from individuals. About 7.7% were obtained on share system. Since most of these lands were owned, then the farmers would be ready to give them more care, conserve them, and follow agricultural extension services that may improve soil fertility such as crop rotation, use of fertilizers and pesticides (table 4.3).

Table 4.3: Distribution of agriculture area and tenure in northern and southern Gadarif area:

Village	Agriculture area (feddans)			Land tenure			
	<1000	**1000-5000**	**>5000**	**Owner**	**Government**	**Share cropping**	**Renting**
North Gadarif	13.5%	30.7%	5.8%	34.7%	11.5%	1.9%	1.9%
South Gadarif	13.5%	28.8%	7.7%	38.5%	3.8%	5.8%	1.9%
Total	27%	59.5%	13.5%	73.2%	15.3%	7.7%	3.8%

Source: field survey 2004/05.

4.2.4. Use of improved seeds in Gadarif area:

All of the varieties cultivated were not improved (100%). Inspite of all these large areas in mechanized rain fall agriculture in Gadarif, yet they were optimally under utilized because they were cultivated with non improved seeds.

The production of one feddans did not exceed two sacks. But if they farm these lands with improved seeds they will get high production. Consequently high revenues obtained would reduce their production cost. Sorghum provides the nation with strategic crop. This will return back in form of higher revenue and export the surplus abroad. When we talk about food security in Sudan or famine, we mean political, social and military security.

All the farmers surveyed obtained their seeds from two sources: mainly from own stocks and from the market. All of these were not improved seeds (table 4.4).

Table 4.4: Distribution of types of seeds and access to seeds in northern and southern Gadarif area:

Village	Type of seed	Market		Stocks	
	Non improved	Yes	No	Yes	No
North Gadarif	50%	21.2%	28.2%	28.8%	21.2%
South Gadarif	50%	17.3%	32.7%	32.7%	17.3%
Total	100%	38.5%	61.5%	61.5%	38.5%

Source: field survey 2004/05.

It may be concluded that the most important factor in decreasing production of sorghum was the use of unimproved seeds in addition to other factors such as:

(1) The wide spread of different weeds, of which buda is the most serious one. Buda causes heavy losses to sorghum crop and it may lead to complete loss of production. It can be reduced by adopting crop rotation, elimination of weeds before flowering, introduction resistant verities such as Mogawim Buda 1.

(2) Insects: The important insects in sorghum crop include: Tempoers, Aphids, American ball worm. These insects can be controlled by early sowing since late sowing subjects the crop to insect infestation.

(3) Diseases: Black smut is wide-spread disease on sorghum, which can be controlled by seed chemical dressing, using Soida dwa or Fernesand.

(4) Rainfall fluctuation: These were due to cutting of forest trees and shrubs in the area, which reduce the vegetative cover and evaporation.

2.5. Sorghum varieties and seed rates:

All types of Feterita crop variety are largely cultivated in Gadarif area. These sorghum crops included: Ajab Sedo Feterita is on top of the list with 48% of respondents followed by Arfa Gadamk, Korakola and Gadamblia (table4.5). The farmers tend to cultivate these varieties because their livestock favor it. Also, in addition to agriculture production, they depended on animal resources, as they owned all kinds of animals such as sheep, camels, cattle, and goats. They introduced livestock in their farming activities in order to decrease crop risks under unreliable low intensity rainfall. Also farmers favor Feterita verities because they don't need high rain like the other varieties. These varieties endure low rainfall of north Gadarif area. Generally, it was argued that the decline of rains in all parts of Gadarif area was enhanced by cutting of forest trees, overgrazing in vegetative cover. Although the clouds were dense in Ethiopia and expected to increase the vegetative cover, yet the Ethiopian authority forbids the cutting of trees to conserve the natural resource base in those areas (personal interview, General Ala Eldin Salih).

It was found that most of the farmers used seed rate of 2-3 kilograms per feddans. Very few farmers in Doka south, about 8%, used seed rate of less than 2 kilograms per feddan (table 4.5).

Table 4.5: Distribution of variety and seed rate in northern and southern Gadarif area:

Village	**Variety**				**Rate of cultivation (kg)**		
	Feterita	**Arfa Gadamk**	Korakola	**Gadamblia flower**	**<2**	**2-3**	**>3**
North Gadarif	13.5%	19.2%	17.3%	-	-	50%	-
South Gadarif	34.7%	11.5%	1.9%	1.9%	7.7%	42%	-
Total	48.2%	30.7%	19.2%	1.9%	7.7%	92.3%	-

Source: field survey 2004/05.

4.2.6. Sorghum producers' experience and soil fertility of lands :

Table 4.6 shows the experiences of farmers to be high as they range between 15-25 years, indicating the degree of knowledge and skill acquired through time by most of the farmers in mechanized rainfall area.

The fertility of soil decreased, specified as medium fertile soil, since the crop rotation was not practiced. Moreover, a farmer who wants to put the land on fallow has to pay a lump sum against a permit card to

the government. The fee was about Ls 280 per feddan each year. If the farmer did not renew the fallow permit for three years, the land will be taken away from him.

But as far as the fertile lands is concerned, there are new lands bought from the government, reclaimed from forests cleaning and cultivated in the recent years. About 11% of the respondents had access to these new fertile lands

Table 4.6: Distribution of experience and soil fertility in northern and southern Gadarif area:

Villages of	**Experience**			**Soil fertility**	
	<15%	**15-25**	**>25**	**High**	**Medium**
North Gadarif	11.5%	21.2%	17.4%	5.7%	40%
South Gadarif	11.5%	28.8%	9.6%	5.7%	48%
Total	I00%	50%	27%	11.3%	88.7%

. Source: field survey 2004/05.

4.2.7. Storage facilities:

All crop producers' warehouses and storage facilities used for storing sorghum were built from cement, stone or bricks. The system of ground pits (matameer) is less in use than in previous years. About 50% of the respondents owned warehouses and about 33% rented storage facilities, while about 17% did not store their crop because they produced low crop production that does not warrant storing of crops (table 4.7).

Table4.7: Distribution of sorghum storage facilities in northern and southern Gadarif area

Village	Storage		
	Owner	Rent	None
Ngadarif	30.7%	13.5%	5.8%
Sgadarif	19.2%	19.2%	11.6%
Total	49.9%	32.7%	17.4%

Source: field survey 2004/05.

4.3. Gross marginal value:

4.3.1. The production cost per feddan:

Production cost is the cost of producing a certain amount of product in a particular time period. For the purpose of calculating, production costs, certain items are determined. The total cost of one feddand includes cost of preparation, planting, seeds, first weeding, second weeding, harvesting, sacks, gathering and taxes.

The average production cost of sorghum yield, prices and gross margins is shown in table (4.8).

Table 4.8: Summary of budget analyses of one feddan of sorghum in northern and southern Gadarif area in 2004/2005.

Item	North	South
1. Total cost (Ls/feddans)	67850	77850
2. Yield (sack/fed.)	1.75	1.75
3. Price (sacks)	55000	55000

4. Gross (3 x 2) return (Ls/fed.)	96250	96250
5. Gross (4-1) margin (Ls/fed.)	28400	13400

Source: Field survey 2004/05.

From the table it was observed that the gross margin revenue of North Gadarif was higher than the South Gadarif. This may be because the high rainfall in Southern Gadarif results in more weed infestation and therefore the cost of weeding was higher. This was reflected in higher cost of production in southern Gadarif compared to Northern Gadarif.

From the table (4.9) the area cultivated and harvested in southern Gadarif were larger than in Northern Gadarif.

It was also found that the area harvested in the two regions of Gadarif counted to about 75% of the area cultivated. Since the cost of production per feddans in Southern Gadarif was grater than that of Northern Gadarif, it was evident that the total cost of production in the former region was much higher than the later one. Consequently, the gross revenue for the whole area of southern Gadarif was grater than that of northern Gadarif as the total gross marginal revenue in Southern Gadarif was negative. Again this incurred loss was mainly due to higher cost of production in Southern Gadarif.

Table 4.9 the budget of sorghum production in Northern and Southern Gadarif area (2004/2005).

Item	**Cultivated area**		**Harvested**		**Value**	
	North	**South**	**North**	**South**	**North**	**South**
Area	57230	61350	42922	46013	-	-
Cost of 1 feddan	67850	77850	-	-	-	-

Cost of total are	3883055500	4776097500	-	-	-	-
Yield (sack)	-	-	1.75	1.75	-	-
Price (sack)	-	-	55000	55000	-	-
Gross revenue	-	-	4131338750	4428751250	-	-
Gross margin revenue	-	-	-	-	24828325	-347346250

Source: Field Survey 2004/05.

4.4. Multiple regressions:

4.4.1. Specification of the model:

Specification of the model depends on many considerations. One basic factor is to determine the dependent variable, which is expected to be affected by the independent variables.

First: one has to decide whether the single equation or system of the equations is appropriate.

Second: choose the set of variables that are relevant to the model.

Lastly: tested hypotheses have to be in an appropriate algebraic form of equation and statistically manageable (Heady and Dillon, 1961).

In this study to show the degree of influence, level of significance and nature of relationship between dependent and independent variables, in a linear production function form was applied (Reynolds 1979). The general form of this function can be written as:

$$Y = b_0 + b_1 + 1 + b_2 x_2 + \ldots. + b_n x_n + e$$

Where:

Y = the dependent variable b_0 = the intercept.

b_1, b_2, b_3, b_4, b_5 = the coefficient (of independent variables)

to be tested

x_1, x_2, x_3, x_4, x_5 = independent variables.

e = the error term.

4.4.2. Factors affecting sorghum production

Table 4.10 shows the result of the specified model that gave a good fit to data with R^2 (0.65) and adjusted R^2 (0.561). This coefficient of determination means that around 56% of the variations in the production of sorghum were explained by variables included in the equation.

F-value statistic of 6.9 is significant over all.

As shown in Table 4.10 the independent variables for sorghum were:

Cultivated area per feddans and time.

$Y = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + e$

$Y = b_0 + 1.374\ (CA) - 0.545\ (HA) - 1.203\ (T) + e$

(3.43) (2.254) (-1.079) (-3.432)

Where:

Y = Sorghum Production.

B_0 = the intercept.

X_1 = Cultivated area.

X_1 = Harvested area.

X_3 =Time effect is a proxy to rain and soil fertility trend.

Table 4.10: Factor affecting sorghum production.

Planetary variable	**Coefficients**	**t-value**	Level of significance
Cultivated area	1.374	2.256	0.045

Harvested area	-0.545	-1.0.079	0.304
Time	-1.203	-3.30452	0.006
Constant	-	3.435	0.006

Source: field survey2004/05.

$R^2 = 0.655$.

Adjusted $R^{-2} = 0.561$

F-value = 6.97.

The significant independent variable can be interpreted follow:

4.4.2.1. Cultivated area:

The cultivated area variable represents the average cultivated area in the study site in season 2004/2005 in feddans. It has the coefficient of (1.374). This coefficient was significantly different from zero. It had a positive effect on production. The coefficient reads as the area cultivated increases by (1%) sorghum production increases by (1.374%).

4.4.2.2. Harvested area (HA):

This coefficient was not significant and had the wrong sign.

4.4.2.3. Time

The independent variable of time had a coefficient of (-1.203), significantly different from zero. It had a negative effect on production and read as time increased by (1%) sorghum production decrease by (-1.203%). Time here may refer to variables not captured by the model. Therefore, time variable may be a proxy for decreasing trend in rainfall and soil fertility.

4.5. Factors affecting sorghum supply to Gadarif market:

Table 4.11 shows the result of the model that gave a good fit to data with R^2 (0.733) and adjusted R^2 (0.553). This coefficient of

determination means that around 73% of the variation in the supply of sorghum was explained by the variables included in the equation.

F-value statistic of 9.153 is significant over all.

As shown in (table 4.11) the significant independent variable for sorghum was time: upper and lower prices for sorghum.

$Y = b_0 –1.-021 (T) + 0.098 (UP) + 0.093 (LP) + e$

(-) (-2.66) (0.233) (0.215).

y = supply of sorghum in Gadarif crop market.

T = time variable.

Up =upper price.

Lp = lower price.

Table 4.11: Factors affecting sorghum supply to Gadarif market.

Explanatory variable	Coefficient	t-value	Level of significant
Time	-1.021	-2.66	0.024
Upper price	0.98	0.233	0.821
Lower price	0.93	0.215	0.8334
Constant	-	8.697	0.00

Source: field survey 2004/05.

$R^2 = 0.73\%$.

Adjusted $R^{-2} = 0.65$.

F-value = 9.153.

4.5.1. Time:

The independent variable time had a coefficient of (-1.021). The coefficient was significantly different from zero. It had negative effect on supply of sorghum. It reads as time increased by (1%) sorghum supply decreased by (1.021).

Time captures variables not reflected in the model equation. These may refer to cost of transportation, cost of taxes, fees paid to the crops in Gadarif market.

4.5.2. Upper price

The coefficient was not significant.

4.5.3. Lower Price

The coefficient was not significant.

Chapter Five

Summary, Conclusions and Recommendations

5.1. Summary:

The main objective of this study was to estimate the effect of different economic factors on sorghum crop performance in Gadarif area. The specific objective was to identify the impact of socio-economic characteristic on production and marketing and profitability of sorghum crop activity in the study area. The study depended on primary and secondary data collection for analysis. The primary data was obtained from a field survey in northern and southern Gadarif areas. The size of the sample was 52 respondents randomly selected from the different villages in the study area.

The method for analysis included description statistics, budget analysis and multiple regression analysis.

5.2. The findings of the study:

Among the many findings of the study, the following were the most important ones:

1. Most of the respondents were in the active age group with high educational level.

2. Most of the respondents were married with small family sizes tendency.

3. Most of the responds had farms ranging between 1000-5000 feddans, mostly owned.

4. All respondents do not use improved seeds.

5. Rainfall in the area is decreasing in intensity, with low, fluctuating crop yields.

6. The budget analysis indicated positive profit per feddan for both northern and southern Gadarif and negative profit for total area in southern Gadarif.

5.3. Conclusions

Among the many conclusions of the study the following were the most important:

1-The marriage status of respondents indicates their extent of bearing of responsibilities, since they are active and highly educated. These farmers are ready to adopt new technology and follow extension services instructions.

2- The farm sizes ranging between 1000-5000 feddans indicates the high cost requirement for investment and operations of sorghum production. These large areas also need high level of management and experience to work them. Since these farmers own these lands, then they will pay all efforts to conserve them.

3- High dependence on rainfall increases the risk of crop production in this area. Moreover, lack of use of improved seeds and continued cultivation of sorghum exhausts the soil fertility and results in low crop productivity per feddan.

4- Unreliable and fluctuating rainfall reduces area harvest when compared to area cultivated. The cost of production is based on the cultivated area while the gross revenue calculation is based on the harvested area. Therefore, it is possible to have a positive or a negative profit due to size of area cultivated, harvested and level of crop production.

5-There has been a positive relationship between crop production and area harvested, and a negative relationship between crop production and rainfall trend or decline in soil fertility trend. The supply of sorghum to Gadarif market was found to be affected by several factors such as cost of transportation, taxes, fees for entering the market and more other factors.

5.4. Recommendations:

1-To use improved seeds according to locality environment.

2- To supply adequate credit for investment and operations of field activities.

3- To introduce new technology and extension services to increase crop production.

4- To grow crops in high rainfall area and use integrated pest management control to reduce effect of buda infestation and other pests and diseases in sorghum.

5- To improve transportation facility to reduce cost of transportation and remove taxes and fees on sorghum marketing.

6- To ensure effective application of environmental regulations and laws in the area. This included the low against forest would cutting.

7- To encourage raising small ruminants in mechanized farming schemes to reduce risk effect in sorghum production due to drought.

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Meetings:

- Abdel Halim Abdel Mohsin: Large farmer in Doka.
- Abu Al Ila: Large farmer in UM Shagara.
- Ala Eldin Salih: Security coordinating officer in Gadarif State.
- Babiker Abdalla Nayel: ASSCO seed propagation expert.
- Hassan Billal: Large farmer in Gadarif town.
- Izzat : ASSCO econmic expert.

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- إدارة التقاوى – التقارير السنوية.

Appendix 1. The cost of production of one feddan of sorghum in Gadarif area for selected seasons during 1992/93-2001/02 in Ls/feddan

Item	1992/93	1996/97	1998/99	2001/02
Land preparation	762.3	1641	3723.6	10500
Crop production				
Seed planting	542.3	1374	3456.6	8450
Weeding	1000	5218.03	11617.7	12000
Others	-	11348	11384	-
Subtotal	1542.3	17940.03	26458.3	20450
Harvesting operations				
Crop harvesting	2100	10692.5	17207.5	-
Mechanical operations	-	-	-	15200
Subtotal	2100	10692.5	17207.5	15200
Agricultural inputs				
Seeds	29	1017.15	1733	2500
Sacks and thread	525	6232	6328	6250
Others	-	-	-	3600
Subtotal	554	7249.15	8061	12350
Other expenses				
Taxes, zakat and fees	776	12480	12480	35000
Transportation	900	3553	7847	8000
Land rent	25.7	200	-	207
Subtotal	1701.7	16233	20327	43207
Grand total	5117.95	25123.2	32111.6	101707

Source: Ministry of Agriculture and Forests, Department of Agricultural Economics.

Appendix 2. Cultivated and harvested area and estimation of sorghum production in Gadarif (area in 000 feddans, output in 000 sacks and productivity in sack/feddan)

Season	Cultivated Area	Harvested Area	Estimated Productivity	Total production (sacks)
1988	3600	3550	4.27	15150
1989	3000	2958	1.52	4500
1990	2007	1826	1.08	1980
1991	4000	3943	1.80	7097
1992	4200	4001	2.00	8000
1993	4000	3882	1.70	6600
1994	4500	4200	3.30	9626
1995	4180	3272	1.81	5912
1996	5231	5154	2.40	12379
1997	4320	3280	1.67	5484
1998	4744	4600	1.00	4622
1999	3910	2869	1.43	4103
2000	3771	2912	1.62	4730
2002	4239	2631.74	1.58	4168.03
2003	4870.11	4187.37	2.26	9488.87

Total production		Total mechanized production		Share of mechanized production	
Sorghum (000 tons)	Sesame (000 tons)	Sorghum (000 tons)	Sesame (000tons)	Sorghum (%)	Sesame (%)
140	1596	75	1144	54	72
81	1180	66	664	81	56

Source: Gadarif Mechanized Farming Corporation (GMFC).

97	3581	85	2695	88	72
266	4042	204	3273	77	81
175	2386	93	1784	53	75
170	6348	105	2922	62	46
313	2450	263	1937	84	79
419	4179	308	2291	74	55
281	2870	216	2192	77	76
225	4284	150	3620	67	85
329	2347	242	1322	74	56
282	2488	225	1583	80	64
232	3146	169	2119	73	68

Appendix 3. Total production of sorghum and sesame crops in Sudan and in mechanized rain fed farming system for the period and the respective share of the mechanized farming during 1989/90-2000/01.

Appendix 4. Cultivated and harvested area and estimation of sorghum production in Gadarif (area in 000 feddans, output in 000 sacks and productivity in sack/feddan)

Season	Cultivated Area	Harvested Area	Estimated Productivity	Total production (sacks)
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2000	3771	2912	1.62	4730
2002	4239	2631.74	1.58	4168.03
2003	4870.11	4187.37	2.26	9488.87

Source: Gadarif Mechanized Farming Corporation (GMFC).

Appendix 5. Average productivity, cost of production and prices of sorghum in Gadarif area for 1991-2000

Season	Average production per feddan	Production cost of ls /lsack	Average price ls/sack	CPE	Deflated value of cost	Deflated value of price
1991	1.8	672	1288	304.9	2.20	4.22
1992	2	934	1425	660.9	1.41	2.15
1993	1.7	2610	3275	1310.9	1.99	2.49
1994	2.2	6000	5925	2843.1	2.11	2.08
1995	1.8	8512	42625	4787.5	1.77	8.90
1996	2.4	18007	25000	11263.5	1.59	2.21
1997	1.7	22931	25000	16179.1	1.41	1.45
1998	3.2	17170	23500	18891.3	.90	1.24
1999	1.4	34282	37250	22037.5	1.55	1.55
2000	1.6	27988	45000	23787.4	1.17	1.89

Sources: Gadarif Mechanized farming corporation (GMFC)

Fig. 2.1 Sorghum crop area in Sudan and Gadarif mechanized rainfed schemes.

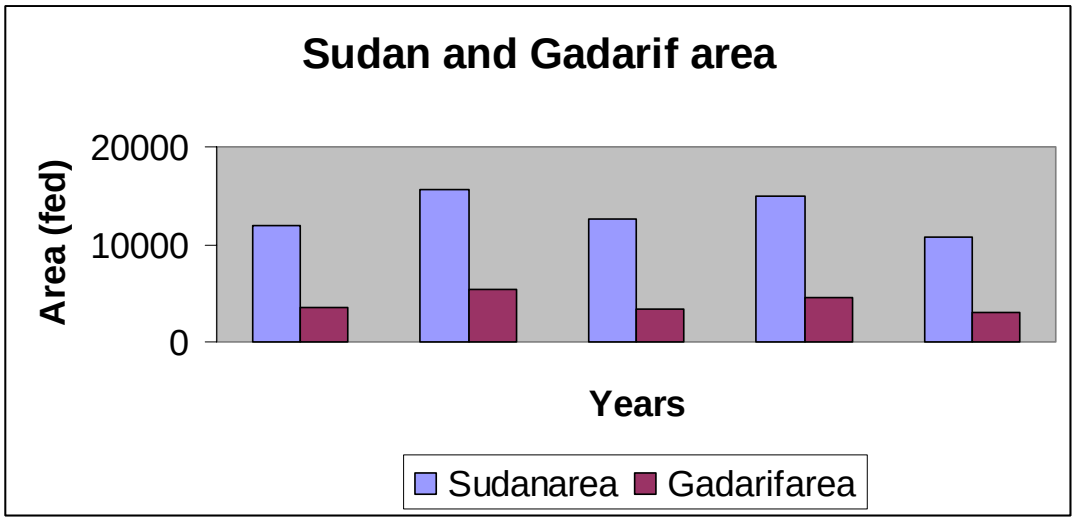


Fig. 3.1 Rainfall distribution in Doka area in Gadarif state 1992-2004.

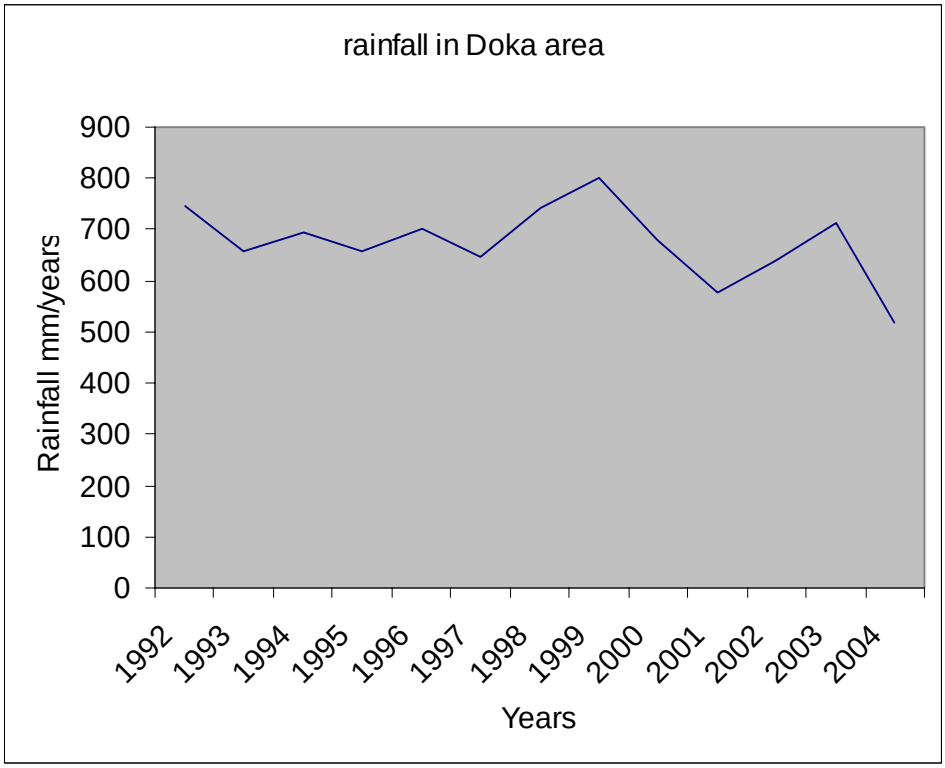

rainfall in Doka area
Rainfall mm/years
900
800
700
600
500
400
300
200
100
0
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
Years

Fig. 3.2 Rainfall distribution in Um Syenat area in Gadarif state 1992-2004.

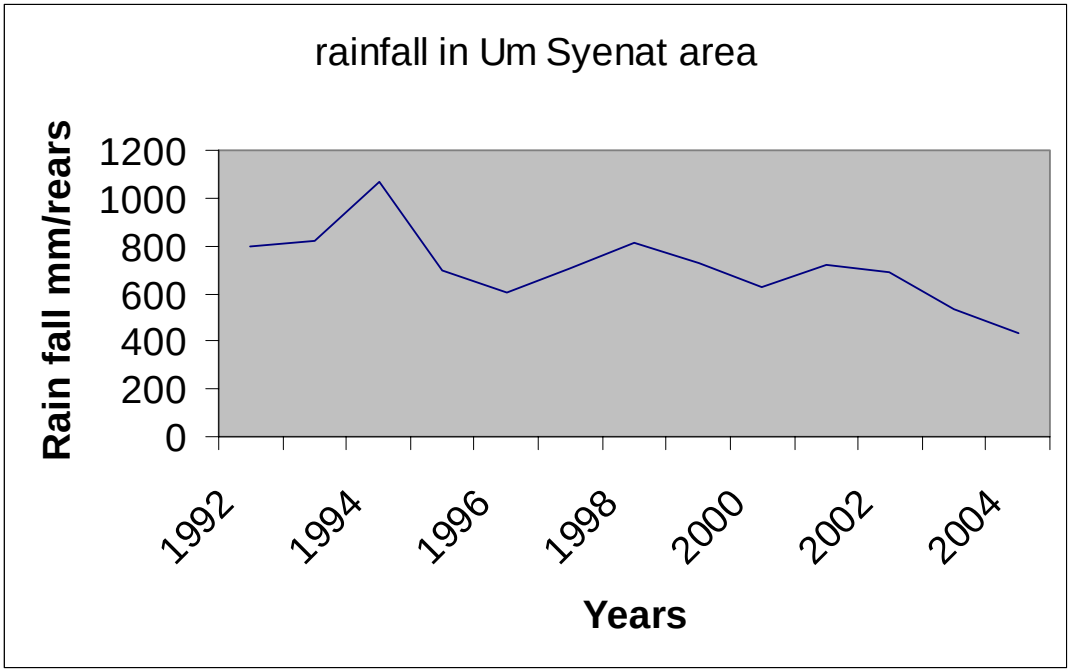


Fig. 3.3 Rainfall distribution in Hawata area in Gadarif state 1992-2004.

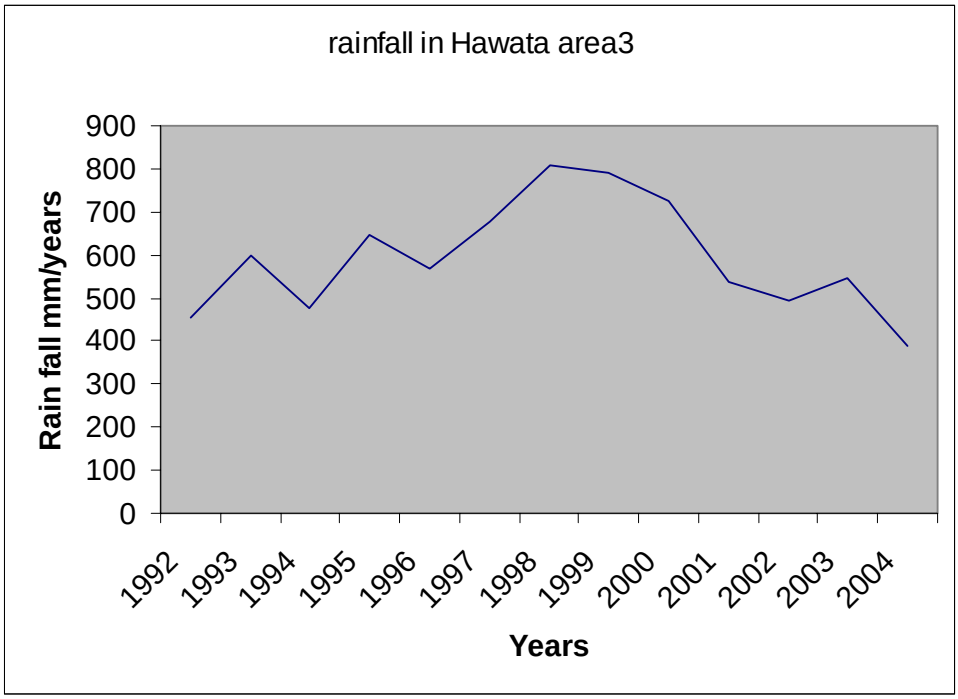


Fig. 3.4 Rainfall distribution in Gadarif area in Gadarif state 1992-2004.

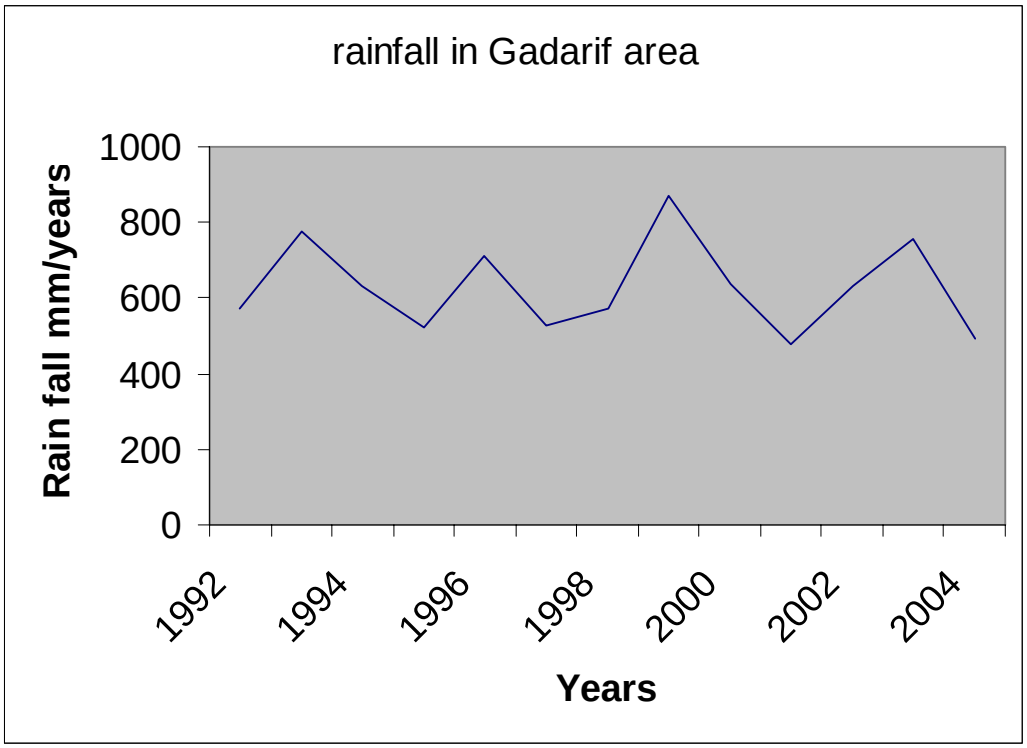
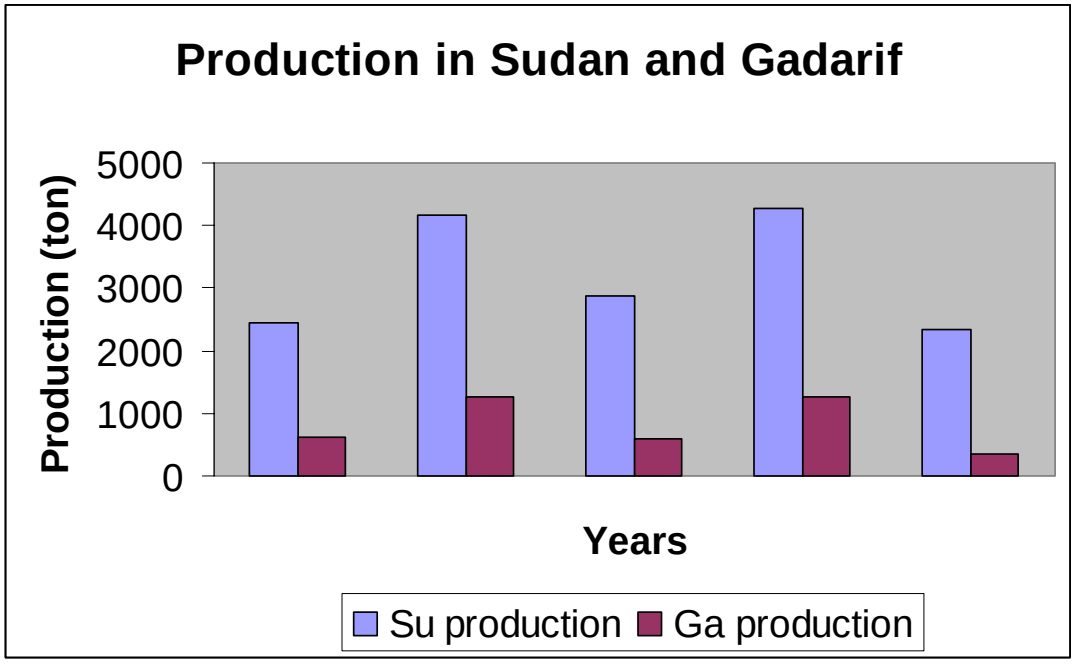
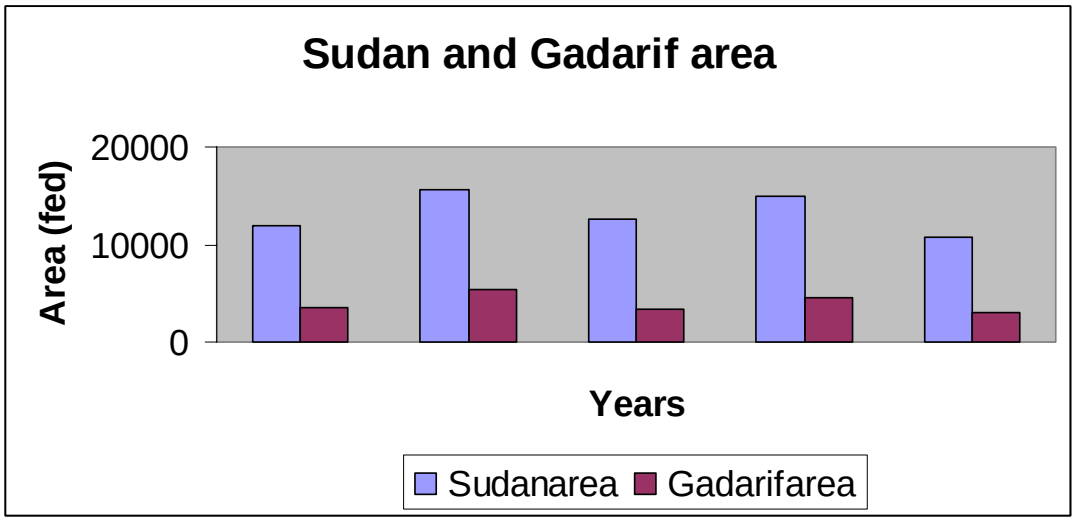
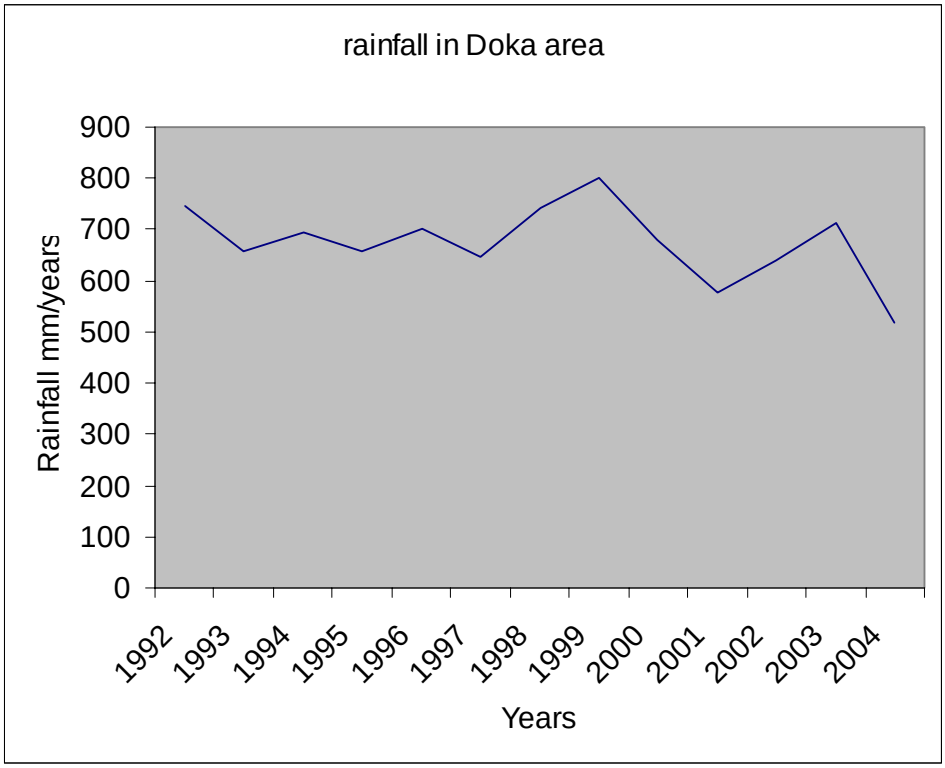
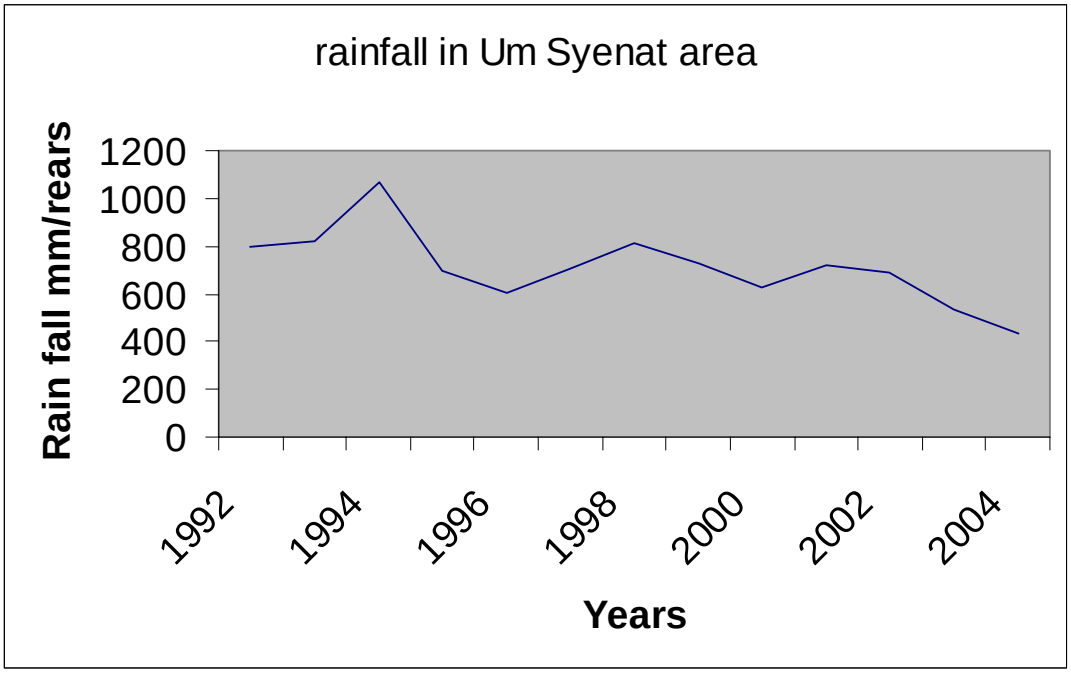


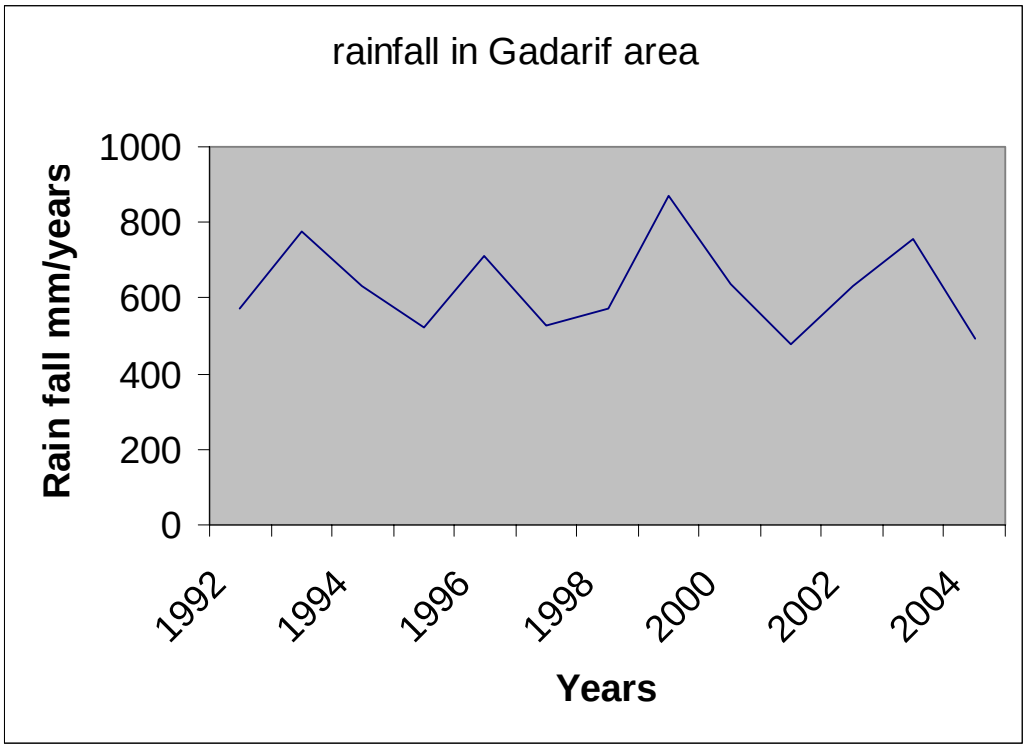
Fig. 2.2 Sorghum crop production in Sudan and Gadarif mechanized rainfed schemes.




Sudan and Gadarif area
20000
10000
0
Area (fed)
Years
Sudanarea
Gadarifarea


rainfall in Doka area
Rainfall mm/years
900
800
700
600
500
400
300
200
100
0
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
Years


rainfall in Um Syenat area
Rain fall mm/rears
1200
1000
800
600
400
200
0
1992
1994
1996
1998
2000
2002
2004
Years


rainfall in Gadarif area
Rain fall mm/years
1000
800
600
400
200
0
1992
1994
1996
1998
2000
2002
2004
Years