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Abstract

Potato is one of most popular and widely grown vegetable in the Sudan. The main potato producing area in Sudan is Khartoum state.

The main objective of the present study was to verify the economics of potato production in Khartoum State. The study was intended to specifically identify and analyze the socio-economic factors related to potato production. It also aimed at studying the characteristics of potato growers and their resource endowment. Moreover, the study assessed and compared the cost and profitability of potato production between the three localities in Khartoum State.

The study depended mainly on primary data which was provided by direct interviewing of potato growers using a structured questionnaire. Other secondary sources of information included Ministry of Agriculture and foresting's annual surveys and reports as well as different local universities.

The survey was carried out during the period February-April, 2007. The data collected was for the season 2005/2006.

Crop budgets, graphical and cross tabulation as well as simple statistical tools were used in the data analysis.

The study indicated that the farmers were a homogenous group since almost all of them shared the same socio-economic characteristic, Seeds, labour, land rent and irrigation were the main cost items which affected potato production. Seed cost represented the highest cost in the three localities.

Karrari Locality recorded the highest price and Sharg El Niel recorded the lowest price.

The regions under study all had positive gross margin profitability and may be ranked in order of coefficient of private profitability as follows: Karrari, Bahri and Sharg El-Neil.

To improve potato production in Khartoum State the study recommends provision of production specialized credit, provision of inputs in a good quality at the right time and at reasonable market prices.

Marketing processing and export of potato need to be seriously studied in future.

خلاصة الأطروحة

يعتبر محصول البطاطس من المحاصيل الأكثر شعبية والأوسع زراعة في السودان وتعتبر ولاية الخرطوم الأولى في زراعة واستهلاك البطاطس.

هدف البحث إلى دراسة اقتصاديات إنتاج البطاطس في ولاية الخرطوم، كما هدفت الدراسة لتحليل العوامل الاقتصادية والاجتماعية المرتبطة بإنتاج البطاطس و دراسة الخصائص المتعلقة بمزارعي البطاطس ومواردهم بالإضافة إلى تقدير ومقارنة التكاليف والربحية لمحصول البطاطس في المحليات الثلاثة بولاية الخرطوم.

اعتمدت الدراسة بصورة رئيسية على البيانات الأولية التي جمعت من المزارعين بالمحليات الثلاث باستبيان صمم لهذا الغرض ، كما دعمت الدراسة بيانات ثانوية جمعت من وزارات الزراعة والجامعات المختلفة ، أجرى البحث الميداني في الفترة من فبراير وحتى ابريل 2007م والبيانات جمعت للموسم الزراعي 2005م/2006م.

وتحليل المعلومات تم استخدام ميزانية المحصول إضافة إلى الرسم البياني والإحصائيات البسيطة.

أوضحت التحاليل الإحصائية للخصائص الاجتماعية والاقتصادية ان مزارعي الولاية متجانسون حيث أكثرهم يشتركون في نفس الخصائص الاجتماعية والاقتصادية.

أظهرت تحاليل التكلفة أن التقاوي - العمالة -الري و إيجار الأرض تمثل التكاليف الأساسية للإنتاج في المحليات الثلاثة بالولاية (كرري ، بحري ، وشرق النيل) تكلفة التقاوي والعمال والري تمثل أعلى النسب من مجموع التكاليف المتغيرة في المناطق الثلاثة ، التقاوي تمثل أعلى التكاليف في المحليات الثلاثة.

اتضح من نتائج التحليل بالنسبة للأسعار أن محلية كرري سجلت أعلى سعر بينما محلية شرق النيل سجلت أقل سعر .

أظهرت نتائج تحليل الميزانية المزرعية أن محصول البطاطس مربح للمزارعين في الولاية وعند مقارنة المحليات الثلاثة نجد أن كرري حققت أعلى ربحية تليها بحري ثم محلية شرق النيل.

وُحسِن إنتاج البطاطس في الولاية أوصت الدراسة بتوفير التمويل الزراعي كما أوصت الدراسة بتوفير مدخلات الإنتاج في الوقت المناسب وبالأسعار المناسبة والجودة العالية كما أوصت بدراسة مشاكل التسويق والتصنيع وإمكانية التصدير.

Chapter One

Introduction

1-1: Agriculture in Sudan:

Agriculture is the most significant element in Sudan's economy and contributes to about 40% of GDP (Taha,2004) The main agricultural sectors in Sudan are rain-fed and irrigated sectors.

A) Rain-fed agriculture:

Most Sudanese farmers rely on rain-fed farming.

Rain-fed agriculture sector has developed as early as 1944/45, when a government project to cultivate the cracking clays of central Sudan started in Gadarif area of the Eastern Province, largely to meet the food needs of army units stationed in the British colonies in eastern Africa. An average of about 6.000 hectares a year was cultivated between 1945 and 1953 , producing chiefly sorghum, under a sharecropping arrangement between the government and farmers who had been allocated land in the project. These estates proved costly, however, and in 1954 the government began encouraging the private sector to take up mechanized farming in the area, a policy that continued after Sudan gained independence in 1956. Under the new approach, the government established several state farms to demonstrate production methods and to conduct research. Research activities have been very limited, however, because of staffing and funding problems, and the farms had been operated essentially as regular production units.

However, the private sector response was positive, and by 1960 mechanized farming had spread into other areas of the cracking clay zone in the Eastern and Middle provinces. By 1968 more than 750.000 hectares were being cultivated , of which it was estimated that more than 200.000 hectares constituted unauthorized holdings. The average agricultural production growth rate

declined, however, from 2.9 percent in the period between 1965 and 1980, to 0.8 percent in the period between 1980 and 1987.

Only few crops had been found suitable for cultivation in the cracking clay area. Sorghum had been the principal one, and during the early 1980s, it was planted on an average of about 80 percent of the sown area.

Sesame and short-fiber cotton were also grown successfully but in relatively smaller quantities , sesame on about 15 percent of the land and cotton on about 5 percent. Soil fertility has reportedly been declining because of the continues planting of sorghum and the lack of crop rotation. Yields have apparently decreased, but in view of the area's greatly varying climatic conditions and the uncertain production data, conclusions on trends appeared premature (FAO, 1991).

B) Irrigated agriculture:

Most of the cash crops are produced by irrigation, and irrigated agriculture represents about 50% of total crop production. The irrigated sector is divided into two main sub-sectors; Large irrigated schemes and small irrigated schemes. The large irrigated schemes are mainly large public ones run by the government in which crop and vegetables are produced, while small irrigated schemes are those in which citrus, date palms , legume crops, wheat and vegetables are produced. Sudan has an irrigation potential of about 4.8 million ha considering land resources.

Taking into account water resources, the irrigation potential has been estimated at almost 2.8 million ha (without considering possible large scale developments at in the enormous wetland in southern Sudan).

The total water managed area is around 1.95 million ha, or 26% of the cultivated area. Some 46200 ha is under spate irrigation in the Gash and Tokar deltas; the rest are full or partial control irrigation schemes. All irrigation water comes from surface water. Most schemes are large-scale schemes, which are managed by Quasi-public Agricultural Corporations (AC), while small-scale schemes are owned and operated by individuals or cooperatives. The combined Gezira-Managil scheme, located between the Blue and the White Nile, constitutes one of the largest irrigation complexes in the world under single management (about 760000 ha). It receives its water from the Sennar dam on the Blue Nile and more than 10000 tenant farmers and their families operate the scheme in partnership with the government and the Sudan Gezira Board, which provides administration, credit and marketing services. Originally planned for the cultivation of cotton, more and more areas are coming under food crop production. Other large schemes are the Rahad Scheme, which receives its water from the Roseires dam on the Blue Nile, and the New Haifa Project (also known as Khaslm AlGirba), located on the Atbara river in the east of the country. The latter project was partly financed by Egypt after the newly constructed High Aswan dam created Lake Nasser, which flooded the Sudanese town of Wadi Haifa in 1964, the inhabitants were moved to the new irrigated agricultural lands where they have been growing a variety of crops for over 30 years.

Although irrigated agriculture has been Sudan's greatest economic investment, returns have been far below potential. A study by the World Bank showed that, during the period 1976-1989, yields were low and extremely variable and cultivated areas suffered gradual decline.

Cropping intensity in the Gezira Scheme, dropped from 75% to 57%, as 126000 ha were taken out of production due to situation and mismanagement of the canals, reducing the availability of water.

Due to bad water management, water supply is about 12% below crop requirements at crucial points in the growth cycle, while at the same time as much as 30% of the water delivered is not used by crops. The new government in Sudan reports that since 1990 there has been considerable improvement in agricultural crop production and returns. Major irrigated crops are cash crops (cotton, groundnut, sugar, wheat and sorghum). (CIA, 1991)

Lately it was reported that, for the 1991-92 seasons, the Ministry of Agriculture and Natural Resources Planned for about 7.3 million hectares of food crops to be planted, with about 1.6 million hectares planted in the irrigated sector and about 5.7 million hectares in the rain-fed areas. With vegetables although very important crops, accounting for less than one percent of the total cultivated area in the country. Vegetables grown in Sudan comprise carrot, pumpkin, tomato, cucumber, onion, lettuce, and potatoes.

1-2: Origin of Potato:

Potato (*Solanum tuberosum*) originated in the high lands of south, America, where it has been consumed for more than 8000 years. Spanish explorers brought the plant to Europe in the late 16th Century as a botanical curiosity. It had spread throughout the continent providing cheap and abundant food for the workers of the industrial revolution.

Today potato is the fourth most important food crop in the world with 300 million tons annual production (CIP, 2008).

1-3: Potato's nutritional value:-

Potato may be used for its nutritional value or processed for its starch content. Nutritionally, Potatoes are best known for their carbohydrate content (approximately 26 grams in a medium potato). The predominant form of this carbohydrate is starch. A small but significant portion of this starch is resistant to

digestion by enzymes in the stomach and small intestine, and so reaches the large intestine essentially intact. This resistant starch is considered to have similar physiological effects and health benefits as fiber: it provides bulk, offers protection against colon cancer, improves glucose tolerance and insulin sensitivity, lowers plasma cholesterol and triglyceride concentrations, increases satiety, and possibly even reduces fat storage (Cummings et al. 1996; Hulla et al. 1998; Raban et al. 1994). The amount of resistant starch in potatoes depends much on preparation methods. Cooking and then cooling potatoes significantly increases resistant starch. For example, cooked potato starch contains about 7% resistant starch, which increases to about 13% upon cooling (Englyst et al. 1992).

Potatoes contain a number of important vitamins and minerals. A medium potato (150g/5.3 oz) with the skin provides 27 mg vitamin C (45% of the Daily Value (DV)), 620 mg of potassium (18% of DV), 0.2 mg vitamin B6 (10% of DV) and trace amounts of thiamin, riboflavin, foliate, niacin, magnesium, phosphorus, iron, and zinc. Moreover, the fiber content of a potato with skin (2 grams) equals that of many whole grain bread, pastas, and cereals. Potatoes also contain an assortment of photochemical, such as carotenoids and polyphenols. The notion that "all of the potato's nutrients' are found in the skin as an urban legend.

While the skin does contain approximately half of the total dietary fiber, more than 50% of the nutrients are found within the potato itself. The cooking method used can significantly impact the nutrient availability of the potato.

1- 4: Potato Production in Sudan:-

Historically, potato was first introduced to Sudan in the late thirty of the Century by two merchants; Manoli, a Greek and Abd Elhadi, an Egyptain (El Hassan, 1989). They used to distribute unknown potato seed tubers introduced

from Egypt to farmers of El Sheheinab and El Geili area, 45 km north of Khartoum to be grown there. They used to purchase the harvested produce and sell it to be grown there. They used to purchase the harvested produce and sell it to the European community in Khartoum and export the rest to Egypt (El Hassan, 1989).

However, other reports (Abdalla and El Shafie, 1983) indicated that the British first introduced potato into the Sudan in the early years of the third decade of the twentieth century. Ever since then potato has gained popularity in the Sudan, especially during the last twenty years. Its relative importance has steadily increased (Tables 1 and 2) and today it is very well known in Sudan and is in fact one of the major vegetables in Khartoum State.

Table (1)The area of cultivated potato in Feddan in the season of the year 2005 in Karrari, Bahri and Sharg El Neil localities.

Locality	Cultivated area in Feddan
Karrari	10053
Bahri	1810
Sharg El Neil	815

Source: Ministry of Agriculture, annual report, 2006.

Table (2) Are a cultivated potato in Feddan in Khartoum State.

Season	Total cultivated area in Feddan
2002	8476
2003	12530
2004	12853
2005	12678

Source: Ministry of Agriculture, annual report, 2006.

1-5: Potato production in Khartoum State:

Khartoum state represents the main area for potato production and consumption in the Sudan. The steady increase in the demand for potato in Khartoum State is due to the recognition of its importance as a valuable nutritional product coupled with the population growth and urbanization of Khartoum which has recently been an area to which people migrate from all other parts of the country to engage in industry and white collar jobs.

Khartoum state produces about 70% of Sudan's total potato production.

The major areas of cultivation are concentrated in Karrari, Bahri and Sharg El Neil localities (Table 1).

The area under potato cultivation in Khartoum State has been estimated as 12678 Feddans in 2005 (Ministry of Agriculture annual State report, 2006, (Table 2).

1-6: problem Statement

Winter season in Sudan is characterized by being a suitable climate for the production of different types of vegetables including potato.

Rapid population growth, rising incomes and migration to urban areas, in addition to the increasing awareness of the consumers on the nutritional value of vegetable, all led to the rising demand for vegetables in general, especially potatoes. However, despite the increasing demand potato still remains a costly crop in the Sudan especially in Khartoum State which is the main region for potato production and consumption.

The unavailability high cost of inputs required for its cultivation, especially seeds represent a difficulty to potato growers. The considerable variation in yield and continuous fluctuation of output prices coupled with the increasing production and marketing costs make the farmers, investors and planners doubtful about the profitability of the crop. In addition to the above, climatic fluctuations and diseases are considered the main constraints for potato growers in Khartoum State.

Therefore, it will be useful to investigate and identify the major factors hindering potato production and to emerge with suitable solutions and recommendations to increase its production.

1-7: Objectives of the Study:

The main objective was to study the economics of potato production in Khartoum State which was achieved through group of specific objectives:

- 1- Assessment of the socio-economic characteristics of farmers and their income.
- 2- Calculation of the cost of potato production.
- 3- Estimation of the gross margins and comparison of the profitability of potato cultivation between the three main localities for potato production.
- 4- Estimation of the variation in the profitability of potato production in the different localities.

5- Estimation of the effect of inputs costs on the profitability of potato production in the producing areas.

1-8: Hypotheses:-

- 1- The population of potato growers in the study was a homogenous group.
- 2- Seeds and labor costs were the main costs items of potato production.
- 3- Variation in production costs of potato between producing areas in Khartoum State was minimal.
- 4- Variation in profitability between production areas in Khartoum State was minimal.
- 5- High input costs reduce profitability for potato producers.

1-9: Organization of the Study:

The study consists of five chapters. Chapter-one includes introduction, statement of the problem, the objectives and hypotheses to be tested.

Chapter-two is a review of potato production in general and specifically in the Sudan. Chapter-three is the methodology of the research. Chapter-four describes the socio-economic characteristics of potato growers and also deals profitability, while chapter-five contains the summary, conclusions and recommendations.

Chapter-Two

Literature Review

2-1 Potato production in the world:

Potato originated in the high lands of South America, where it has been consumed for more than 8000 years. Today, potato is the fourth most important food crop in the world with a 300 million ton annual production (CIP,2008).

In the temperate zone, potatoes are usually considered as a staple food. In the last decades, potato became also more and more popular as a vegetable in many tropical and sub-tropical countries. Zaag (1989) stated that from 1974 to 1986 the total area in the world cropped with potatoes increased by 8%, total production increased by 6% due to increase in yield. In developed countries, the area decreased by 15% and total production by about 2%. In the Netherlands, the acreage under potato is a proximately 19500 hectares. A great part of the production is exported either in fresh or in processed form (kuiper,19890). FAO reports that the world production of potatoes in 2006 was 315 million tones. The largest producer, China , accounted for one-fourth of the global output, followed by Russia and India.

In this year 2008, several international organizations began to give more emphasis to the potato as a key part of world food production, due to several developing economic problems. They cited the potato potential for a beneficial role in world food production, owing to its status as a cheap and plentiful crop which can be raised in a wide variety of climates and locations (Wade,2008).

In recognition of this importance, the United Nations officially declared the year 2008 as the International Year of the Potato (Khlaeej times, 2008) in order to "increase awareness of the importance of the potato as a food in developing nations".

2-2: Potato Production in the Sudan:

Potatoes in the Sudan are currently considered as a high cost vegetable. However, the potentialities for its production appear to be promising in the future as food security is now a central issue for the policy makers in Sudan.

Potato can play an important role in diversifying cropping systems and food supplies in the market. It is quiet seasonal being abundant in February, March and April and diminishing from August to December.

This seasonality causes sharp price fluctuations and gives the off season crop from Jebel Marra, which is of inferior quality , an opportunity to find a market in the large cities of central Sudan.

Genief et al (1989) reported that the potential for improvement of potato production is enormous and feasible, if certain constraints and limiting fields are alleviated. Market demand for quality potatoes in Sudan greatly exceeds the supply. This is manifested in the markedly high prices of potatoes in all markets in the country. These prices are still higher during the off-season period (August-December).

The low supply of potatoes can be attributed mainly to the low yield obtained per unit area and also to the insufficient areas for growing potatoes.

2-3: Agricultural Inputs:

2-3-1: Potato seeds:

Seeds for planting are imported annually from Holland. Usually, the seed tubers arrive late and not in a high physical condition for immediate planting (El-Amin, 1989). Late planting can significantly reduce yield and tuber quality as well.

Due to the high cost of seeds, farmers plant less seed tuber per hectare than required by subdividing the seed tuber into small pieces.

However, planting of these cut small tubers results in decay incidences, less numbers of stems per unit area and consequently low production density and therefore low yield. Also, to reduce costs, some farmers in Khartoum area store their own seeds for planting in the next following growing season in October and November. Unfortunately, these locally produced seed tubers result in very low yield as the long storage period can result in poor physical seed quality especially in situations where there is shortage of electricity.

Seeds imported annually, being imported from temperate regions have many disadvantages as summarize by El-Aming (1989);

- 1- The high cost of potato seeds and the shortage in their supply, classify potato as an expensive vegetable.
- 2- The seed tubers represent about 76% of the total cost of potato production.
- 3- Seed tubers are perishable, carriers of potato pests and diseases.
- 4- Potatoes are often planted late due to the late arrival of the seed tubers to the Sudan.

El-Amin (1989) summarized the advantages of the true potato seeds as follows:-

- 1- The true potato seed are free from pests.
- 2- One ton of true potato seed is enough for sowing 20.000 feddans of land.
- 3- True potato seeds are easy and economical to transport and store.
- 4- Using true potato seeds can expand area under potato cultivation and hence potato can be made available at any time of the year.
- 5- True potato seeds are considered low cost planting materials.

Many farmers, north of Khartoum tended to use seeds from a previous season due to the late arrival of potato seeds from Holland and the high price of these seeds.

Badei et al. (1987) revealed that the repeated use of seed potato leads to high degeneration rate; due to the build up of viral diseases; the repercussion of which will be the progressive decline in yield and quality.

In 1988, a joint project between Sudan and Holland (Zagg, 1989) was established in Shendi area with the aim of devising a local potato seed production in order to supply potato growers with good quality seeds and render Sudan less dependant on imported seeds.

In the season 1989 , the project covered approximately 20% of the national demand; the main investment in the project was to be a cold store, which has as yet not been implemented due to its relatively high investment cost. The project stores the produce in cold store to be distributed later as potato seeds for potato farmers early in the next season.

Besides seed potato production, the project also aims at enhancing potato technology with existing research and extension institutions . However, Zaag (1989) recommended the continuation of the seed multiplication program (Potato Development Project) in Shendi area and the same time study of the potential of seeding tubers as a source of seed supply in particular isolated regions.

Ahmed et al (1989) claimed that the major limiting factor for extension in potato production was the high cost and unavailability of seed tubers , the solution to this problem is to develop a technology to produce potatoes from true seeds.

2-3-2: potato Varieties:

The short growing season for potato in the Sudan, followed by temperature, requires varieties with special adaptation to these conditions.

For many years, farmers received from Holland the variety Alpha that is not well adapted to climatic conditions in the Sudan and gave lower yields. Relatively, higher yielding varieties like Spunta were recently imported. Major improvements can occur from varieties with heat tolerance and disease resistance.

Recently many other varieties have been imported like Ballena, Mondial, Almera, Armada, Sfari, Draga, Becaso, , Alasca, Everst

2-3-3: Fertilizers:

Most soils have pH 7.5 and are deficient in phosphorous, zinc and magnesium usually apply nitrogen (urea) but do not apply phosphorous. (Ehtassan,1989) investigated the response of potato plants to fertilization with chicken manure, super phosphate and potassium sulphate as well as their combination. There was positive response of potato plants to the super phosphate and potassium sulphate fertilizers.

Chicken manure, as an organic fertilizer resulted in higher yields than super phosphate and potassium sulphate fertilizer used individually.

However, combination of the chemical fertilizers outyielded the chicken manure.

2-3-4: Pests and Disease:

Many chemicals are used to protect potatoes. The use of chemical pesticides on potato is increasing in developing countries, as farmers intensify production and expand cultivation into areas and planting seasons beyond the

crop's traditional range. The chemicals used are frequently highly toxic and applied with little or no protective equipment (FAQ, the international year of the potato, 2008).

The result is alarming levels of pesticide poisoning in farming communities. Insecticide absorbed by soil often penetrates subsequent crops and runs off to contaminate water supplies. Overuse of pesticides even compounds pest and disease problems; in Colombia, outbreaks of a viral disease have been linked to insecticides that wiped out natural predators of the disease's vector.

Increasing potato production while protecting producers, consumers and the environment requires a holistic crop protection approach encompassing a range of strategies – encouraging natural pest predators, breeding varieties with pest/disease resistance, planting certified seed potatoes growing tubers in rotation with other crops, and organic composting to improve soil quality.

There is no effective chemical control, for example, against bacterial wilt. But planting healthy seed in clean soil, using tolerant varieties in rotation with none susceptible crops and other sanitation and cultivation practices can lead to significant reduction of the disease.

Incidence of potato tuber moth can also be reduced by preventing soil cracking that allows moths to reach the tubers.

Both the International Potato Center (CIP) and FAO advocate Integrated Pest Management (IPM) as the preferred pest control strategy during production. IPM aims at maintaining pest populations at acceptable levels and keeping pesticides and other interventions to levels that are economically justified and safe for human health and the environment (FAO, the international year of the potato, 2008).

Even here in Sudan many studies were conducted regarding protection of potatoes. Altayeb and Idris (1989) reported that the variety Alpha was susceptible to attack by early blight, whether the plants were raised on first or second grown tubers.

The most important diseases that affect potatoes in the Sudan were summarized by Zaag (1989) and include the tuber moth, cut worm, aphid and early blight.

Abdalla (1989) stated that the chemical sprays reduced the transmission of diseases. The effect in reducing the incidence of vireuses was more pronounced in the early planting than in late planting stage.

Also, the seed tuber produced from early planting save higher yields than those from late planting.

Badei (1989) concluded that the following cultural practices substantially reduced the incidence of tuber moths:

- 1- Light soils.
- 2- Sowing at three inches depth.
- 3- Sowing on north-south direction of the ridge.
- 4- Early harvesting.

He also concluded that the following two operations affect the control of whitefly and Aphids.

- 1- Spraying the leaves of potato with "Neem" extract at the rate of 1 kg seed of Neem in 2 liters of water.
- 2- Spraying of tubers after harvesting with Neem leaves water extract then bagged in jute sacks.

2-4: Post Harvesting Operations:

2-4-1: Storage of Potato in Khartoum State:-

Potato is a seasonal vegetable and the process of storage is very important function to regulate the flow of potato over the year to meet the continuous demand. Potatoes are left in the field covered with died grasses (Bota). After approximately two weeks, tubers are cleaned and either packed in sacks for sale in the market or stored in traditional storage system pits or taken to cold-stores.

Pit storage is still used due to the high cost and limited number of cold stores. Pits are damped with water then lined with Neerm leaves.

These pits are made under a tree shade or a traditionally shaded room known as Rakouba. The damp pit is loaded with potatoes and covered with dry grass (personal communication).

(Kahil,1989) revealed that pits were commonly used by potato growers especially by those who fail to secure some space in the commercial cold stores. He reported that pits storage resulted in high losses ranging between 12.35-35% after two months storage of Alpha variety.

Kahil in the same study made a comparison between storage in commercial and experimental cold rooms for 5-6 months. He concluded that the total loss of potatoes from the commercial cold room (11.3%) was higher than of the experimental cold room (5%) for the same storage period. The reason for the difference was the poor air distribution, stake pattern, room size and limited use of back-up generator stacking power cut.

(Yousif 1989) found wide variations of temperature at different locations of commercial cold room (4.1 – 12.9 C) compared to better uniform temperature pattern of experimental cold room (4.7 – 5.5 C).

The cost of storage is very high due to the limited number of commercial cold stores. The current storage is very high due to the limited number of commercial cold stores. The current storage cost of a 50Kg/sack is SDG 2-2.5/Sack 1 month.

On a general basis, the success of storing potatoes was summarized by Zaag (1989) in the following:-

- 1- The quality of the tubers.
 - 2- The storability of the variety.
 - 3- The possibility of regulating temperature and humidity in the cold stores.
- Also, improvement of pits storage is not only of importance for Sudan but also for several other countries.

The peak supply period of potatoes is between February and April. Khartoum State market absorbs more than 80% of the potato produced in the state. The period, January and February coincides with the early harvest of potato and the period early March to April is for fresh potatoes and the period May to November represents the period of cold stored potatoes while period from April to July for pit stored potatoes and the period from November to December is covered by Zalinge potato.

2-4-2: Marketing System:

Unlike rice, wheat and maize, potato is not a globally traded commodity and its prices are determined usually by local supply and demand. A recent FAO survey in more than 70 of the world most vulnerable countries found that inflation in potato prices is much lower than that for cereals. The potato is , therefore, a highly recommended food security crop that can help low-income countries ride out turmoil created by food price increases (FAO, the international year of the potato, 2008).

In Sudan, Ahmed (1992) stated that the marketing of potato was practiced in a traditional way as compared to that of other countries and is

overall inefficient. This leads either to seasonal or chronic shortages or surpluses.

The consumer price of potato declines during March-April due to increase of supply and price increases in summer coinciding with lowest average quantity supplied. The marketing costs and margins for potatoes showed considerable differences between the periods of selling.

Chapter three

Research methodology

3-1: Area of the study:

The area of cultivated potato in Khartoum state season 2005/2006 was about 12678 Feddan.

There are three localities in Khartoum State engaged in potato cultivation, namely Karrari, Balirir and Sharg El Neil. The enervation area in Karrari extends from Abu-Roaf to Goz Nafisa in the western bank of the River Nile in an area of about 10053 Feddan 80% to the total area of potato cultivation in Khartoum State. Karrari represents the main locality in potato cultivation in Sudan.

On the other hand, the cultivated are in Bahri extends from El-Ezeragab to Dabak in the eastern bank of the River Nile, in an area of about 1810 Feddans which is about 14% of the area cultivated in Khartoum State.

The cultivated area in Sharg El Neil locality extends from El-Esielat to Kotrang in the eastern bank of the Blue Nile in an area of about 815 Feddans and is about 6% of the total area of cultivated potato in Khartoum State (Ministry of Agriculture, annual report, 2006).

3-2: Sample Design:

El-Shehienab was selected to represent Karrari locality. On the other hand Algaily was selected to represent Bahri locality and El-Esielat was selected to represent Sharg El-Neil locality.

These villages were selected due to the following reasons:

- 1- They are three biggest centers of potato production in the three localities.

2- Potato growers in these three villages are highly experienced.

3-3: Data collection:

Data from various sources has been collected for the study. The study deepened mainly on primary data which was conducted during March 2007 by interviewing the farmers.

Potato growers were interviewed about the season 2005 in order to study the socio-economic characteristics, cost, revenue and profitability.

3-4: The questionnaire:

The questionnaire was designed in a way to give six categories of information.

Category one: Demographic characteristics about age, marital status and educational level of farmers (illiterate, Khalwa and elementary education).

Category two: Economic characteristics of potato planted areas (Feddans) in size and land tenure.

Category four: productivity and price of the potatoes.

Category five: costs of production, which includes land preparation, seeds, fertilizer, pesticides, irrigation, land rent and harvesting cost.

Category six: constraints hindering potato growers: climatic fluctuations, soil fertility, size of land, inadequate inputs, inadequate finance, diseases, increase in transportation and packaging material costs.

3-5: sample Size:-

The level of precision can be improved by increasing the sample size or by stratification of the mother population into strata to ensure homogeneity (sub-sample) (Haddad,2000).

Many sampling techniques are available such as systematic, cluster, multistage stratified and random sampling. The stratified random sampling was chosen since it suited the purpose of the present study.

Stratified random sampling as its name suggests, is a sampling design where population is stratified into an overlapping sub-group called strata.

Each sub-group has some common characteristics. Once the strata are identified, simple random sampling is under taken at stratum level.

These strata are represented respectively by El Shehainab Algaily and El Eseilat villages.

Unfortunately, the exact number of potato growers was not available. The population of the study was stratified into three strata:

- 1- Karrari
- 2- Bahri locality.
- 3- Sharg El Neil locality.

A sample of 60 growers was randomly selected, 20 from each of the following villages; El hehienab, Wad-Ranili and El-eseilat.

3-6: Analytical Techniques:

To achieve the objectives of this study, different analytical techniques were used to analyze the survey data.

3-6-1: Descriptive Analysis:

The descriptive part of the analysis consisted of frequency distribution and tabulation of the results which were used to explain the socio-economic characteristics of the farmers in the area under study.

3-6-2 Crop Budget Analysis:

the crop budget analysis was used to estimate the profitability of potato production in the three localities of Khartoum state.

Budget may be defined as detailed quantitative statements of a farm plan or change in farm plan, and the forecast of its financial situation (Ahmed, 1995). In this respect, gross margins were calculated using the output price and the cost of production per Feddan.

Total variable costs were calculated by summing up each of the different variable costs in the production process. Then the gross margin per Feddan for each agricultural region was calculated by subtracting the total variable costs from the gross returns. Also, the percentage of the different costs of the items in the total production cost was estimated to indicate the respective share of each item.

Chapter four

Results & Discussion

4-1 introduction:

This chapter aims to describe the socio-economic characteristics of potato farmers in the different producing area in Khartoum State. The chapter also attempts to develop the relationship between the different socio-economic characteristics of potato farmers and the production and profitability of the crop.

4-2: The general Features of Socio-Economic characteristic of potato farmers in Khartoum State.

4-2-1: Effect of Age:

The researcher (Tauer,1978) reported that the age had a positive effect on the productivity and output until a certain level beyond which it would start to decrease.

However, Ali et al. 1979 argued that there is generally a negative correlation between farmer's age and the rate of adopting innovation so younger farmers adopt new ideas more readily than older ones.

In the present study, most of the farmers (73.4%) producing potato in Khartoum State were in the age group between 30-60 years, and had an average production range between 4.022-4.124/tons in feddan, with income ranging between SDG 6505-7560. Whereas the age group less than 30 years of age were 11.7% of the total farmers in the study and had an average production of about 4.571 tons per Feddan and average income about SDG 7921. This indicated that the production of potato had a negative correlation with the farmer's age.

Table (4-1): The relationship between farmer's age, productivity and income

Age (years)	Frequency	percentage	Production ton/Feddan	Income SDG
Less than 30	7	11.7	4.571	7921
30-46	31	51.6	4.124	7560
45-60	13	21.7	4.27	6506
60 and above	9	15.0	4.4	6310
Total	60	100		

Source: Field survey 2007.

4-2-2: Effect of experience:

The survey result showed that 61.7% of the potato farmers in Khartoum state had ten years or more of experience in crop production. The average production in this level was about 4.576 tons per Feddan with income of about SDG 7981. Also, this indicated that the production of potato had a positive correlation with the farmers experience because ten years or more experience was coupled with more productivity than less experience as shown in the table below.

Table (4-2) The relationship between farmers experience, production and income:

Year of experience	Frequency	Percentage	Production ton/Feddan	Income SDG
Less than 5	6	10	3.667	5950
5-10	17	28.3	3.559	5894
10 or more	37	61.7	4.576	7981
Total	60	100		

Source: Field survey 2007.

4-2-3: Effect of Education:

The level of farmer's education is assumed to have significant effect on the output of agricultural crops. Highly specialized production is unthinkable without an equally high level of education (Enyoudi and Volgyis, 1982).

Upton in 1987 reported that education had an important influence on managerial ability and decision making. Used in its broadest sense, education must include not only formal schooling but also agricultural extension and indeed any experience which broadens the knowledge.(El Awad,1994)

found out that education and age variables were negatively correlated to yield of wheat crop. This was probably due to the engagement of farmers in activities other than farming, therefore reducing their actual hours of supervising crop fields.

In agricultural production, Gladwin (1992) reported that the major production constraint in the developing countries was the lack of knowledge about the importance of certain modern inputs due to the lack of extension and farmers education program in general.

Elhadri (1986) reported that illiterate farmers were found to be reluctant to adopt modern techniques and were still using primitive tools and tended to use the traditional agricultural practices of their ancestors.

The survey results showed that about 93.3% of potato growers in Khartoum state had some level of education; their average production was about 4.098 tons per Feddan and income about SDG 7014. Also, about 51.6% of potato growers had secondary or higher education, their average production was about 2.218 tons Per Feddan, and average income of SDG 7469.

Table (4-3)The relationship between farmers’ educational level, production and income

Level of education	Frequency	Percentage total	Production. ton/Feddan	Income SDG
Filtrate	4	6.7	4.650	60.70
Primary	25	41.7	4.098	7014
Secondary or higher	31	51.6	4.218	7469
Total	60	100	4.197	7186

Source: field survey 2007

4-2-4: Effect of the size of holding:

Ahmed and Zahlan (1986) reported the size of land holding measure in Feddan is assumed to be one of the most important classical inputs that had an influence on the output of the different crops grown. The quality of the land is also important because it differs in quality from one place to another. Accordingly, land is expected to explain most of the variation in the output of the main crops grown in the traditional areas.

Handing (1982) stated that in modern agriculture, the comparative profitability of an individual price is frequently measured in terms of its return to land because it is the most limiting resource that determines the level of productivity.

The present study showed that of the frames in Khartoum state had land holding between 5 and 10 Feddans (46.7%) while 18.3 had land holding of less than 5 Feddan 31.7% ha land holding ranging between 10 and 15 Feddans and 3.3% had of land holding of more than 15 Feddans.

There was a significant difference in production and income level between farmers with holdings between 10 and 5 Feddans and those who had more than 15 Feddans. The groups of frames who had between 10 to 15 Feddans were able to obtain an average yield of 4.295 tons per Feddan and an average income of SDG 6957. While the group who held 15 or more Feddans were able to average yield of 5.750 tons per Feddan and an income of about SDG 10750 .

Table (4-4) The holding size category distributed by farmers average production (ton/fed) and average income in SDG.

Level of education	Frequency	Percentage total	Production. ton/Feddan	Income SDG
Less than 5	11	18.3	3.473	5973
5-10	28	46.7	4.304	7567
10-15	31.7	31.7	4.295	6957
15 and above	3.3	3.3	5.750	
Total	60	100		

4-2-5: Effect of land tenure:

The present study also investigated the effect of land ownership upon production level. The survey showed a significant difference between land owners and other types of tenures.

The result showed that 35.0% of the farmers in Khartoum state rented, 31.7% owned and and 33.3% both rented and owned their land. Farmers renting land had average production of about 5.071 tons per Feddan, and average income about SDG 9324. The farmers who owned the land had a yield of about SDG 6674. The result above indicated that the renting land farmers exerted more effort and supervision than farmers who owned the land because renter farmers had a higher additional cost than farmers who owned land.

Table (4-5):The relationship between ownership, productivity and income:

From land tenure	Number of farmers	Percentage	Production ton/Feddan	Income SDG
Rental farmers	21	35.0	5.071	9324
Owned	19	31.7	4.076	6674
Both	20	33.3	3.392	5429
Total	60	100		

4-2-6 Distribution of farmers according to income level:-

The survey result also indicated that the gross income earned by potato producers in Khartoum state ranged from less than SDG 2000 to more than SDG 7000. About 1.7% of the farmers earned less than SDG 2000. Whereas 21.7% earned between SDG 2000-4000, about 36.7% earned SDG 4000-7000

SDG and% earned SDG 7000 or more (Table 4- 6). Most of potato growers (76.7%) in Khartoum state earned more than SDG 4000.

Table(4-6):The distribution of farmers according to the level of income:

Range of income SDG	Number of farmers	Percentage
Less than 2000	1	1.7
2000-4000	13	21.7
4000-7000	22	36.7
7000 and more	24	40.0
Total	60	100

4-2-7: The relation between age and experience on the level of production:

The relation between age and experience on the level of production of potato was also investigated. It was found that production of farmers who were less than 30 year old increased with increased in experience. For example those farmers who had experience of 10 year or more were able to obtain about 6.250 tons of potato per Feddan. On the hand those who had experience of 5 to 10 years were able to obtain only 4.292 tons per Feddan.

Similarly, farmers 60 year old more, had more experience and were able to obtain higher levels of production per Feddan (Table 4-7). However, when comparing the performance of the two age groups; those less than 30 year and those above 60 years, it was observed that the farmers group less than 30 year of age obtained the highest productivity level in comparison with the experience of all the other categories. This might be explained by the degree of activity required for potato production and which can achieved by the younger rather than the older ones.

Table 4-7: The relationship between age and experience on the level of production

Age (years) \ Experience	Less than 30	30-45	45-60	60 or above
Less than 5	Zero	2.333	5.000	Zero
5-10	4.292	3.281	2.2500	3.500
10 and more	6.250	4.730	4.044	4.513

Source: field survey 2007

4-3: Analysis of variable costs of production:

The cost items were calculated in order to determine the respective share of each item in the total cost of production and to compare the production cost for different production sites in the study area (tables: 4-8,4-9,4-10).

4-3-1 land preparation cost:

Farmers in the study usually clean the land between September and November. Cleaning is usually with a traditional tool named torya. Ploughing, harrowing leveling and ridging are carried out by tractor in October and November.

The survey results of the present study indicated that average cost of land preparation was about 151.5 in Bahri locality. The highest cost for land preparation was recorded for Sharg El Neil while the lowest cost was recorded for Bahri locality . The difference in preparation costs may be due to the fact that some farmers did not actually perform all the required land preparation mentioned above and may also be due to differences in soil types as well as cost of rent (Table 4-11).

4-3-2 Cost of labour:

Cost of labour include cleaning, weed control, tradem and harvesting costs.

The survey results showed that average of cost labour per Feddan was about SDG 584.25 in Sharg EL Neil, while it was SDG 800.45 in Karrari and SDG 563.25 in Bahri locality. The highest cost of labour was recording for Karrari while the lowest cost was recorded for Bahri.

4-3-3: Costs of inputs:-

The survey showed that the average of cost seeds was about SDG 1224.5 per Feddan in Sharg El Neil, about 1179 in Karrari and about SDG 1005.5 in Bahri.

4-3-3-1: Seeds cost

The highest cost of seeds was recorded for Sharg El Neil, while the lowest cost was recorded for Bahri locality

4-3-3-2 Fertilizer cost:-

The chemical fertilizer used by the farmers in the study area was urea which was applied as two doses . the first dose was applied at the second irrigation and the second dose was applied at time of ‘tradeem,’. The amount of fertilizer either from the market or the Agriculture Bank. The survey result showed that the average cost of fertilizers per/Feddan was about SDG 258.5 in Sharg El Neil, SDG 253.25 in Karrari and about SDG 350.55 in Bahri locality.

The highest cost of fertilizers was recorded in Bahri while lowest cost was in Karrari.

4-3-3-3: Pesticides:

Farmers who cultivated potatoes used chemical pesticides to control pests and diseases. The pesticides used by farmers included Byleton 25% Folimat 800 SL, Suricidin, Danitol 20% EC, Surnicidin, Danitol 20% EC, seicron and Tilli.

Farmers applied about 1 or 2 liters of pesticides per Feddan. The average cost of pesticides per Feddan was SDG 49 in Sharg El Neil, about SDG 80.45 in Karrari and about SDG49 in Bahri locality.

The highest cost of pesticides was recorded in Karrari while the lowest was in Sharg El Neil locality.

4-3-4: Cost of land rent:

The survey results showed that the average cost of the rent per Feddan was about SEG 375 in Sharg El Neil, about SDG 416.66 in Karrari and about SDG 425 in Bahri locality.

recorded in Bahri while the lowest in Bahri while the lowest was in Sharg El Neil.

4-3-5: Cost of irrigation:

The result showed that the average cost of irrigation per feddan was about SDG 420 in Sharg El Neil, about SDG 662.75 in Sharg El Neil, about SDG 662.75 in Karrari and about SDG 306. 25 in Bahri locality. This result indicated that the highest cost of irrigation recorded ion the study was in Karrari while the lowest was for Bahri locality.

4-3-6: the cost of Marketing:

The results showed that the average marketing cost per Feddan was about SDG 165.8 in Sharg El Neil, about 430.8 SDG Karrari and 192.5 SDG in Bahri . The

highest cost of marketing was recorded in Karrari, while lowest cost was recorded in Sharg El Neil.

4-4: Total Variable cost of production:

Summing up the pervious cost items gives the variable cost of production, which was found to be SDG 3241.55 for Sharg El Neil, Bahri, Karrari .

Sharg El Neil recoded the highest cost of production due the high cost of labour , irrigation and marking. Bahri locality recorded the lowest cost of production due the lowest cost of seeds and irrigation.

4-5: Analysis Crop Budgets:

The cost of production per Feddan was calculated in order to identify the magnitude of each item in the in the total variable cost. It was obvious that seeds and labour costs constituted the high share in the total variable costs of production for the three localities. (Table 1) represents the respective share of each cost of production for the different areas.

4-6: analysis of Crops retunes:

4-6-1 Crop yield:

According to the fields survey, the average yield in Sharg El Neil was about 2.84 tons per Feddan, in Karrari about 6.02 tons per Feddan and in Bahri locality about 3.73 tons per Feddan. The highest yield was recorded in Karrari, while the lowest was recorded in Sharg El Neil locality.

4-6-2: Price of the Crops:

The average price of potatoes in Khartoum state reflected by the field survey was found to be SDG 1536/ton in Sharg El Neil, SDG 1786/ton in Karrari and SDG 1606/ ton in Bahri locality. The highest price was recorded in Karrari while the lowest price was recorded in Sharg El Neil. Potato price fluctuated not

only among seasons but also within the same season due to quantity of crops supplied. Potato price fluctuation not only between seasons but also within the same season due to quantity of crops yield.

4-7: Gross Returns:

The gross return was obtained by multiplying the average yield by average price. On average the gross return obtained were about SDG 10760.65 per Feddan in Karrari in , 5990.38 SDG in Bahri and SDG 4362.24 in Sharg El Neil. The highest gross return was recorded in Karrari due to the high price and yield., while the lowest gross return was recorded in Sharg El Neil due tot the lowest price and lower yield of product.

4-8: Gross Margin and private profitability:

Gross margins are the net profit of the gross income (Heady and Jenseue, 1954). In the words, the gross margin is obtained by deducting the variable expenses from the revenue. The survey budgets revealed that the gross margins obtained were about SDG 1120.69 per Feddan in the Sharg El Neil, about SDG 6777.54 in Karrari and SDG 2936.53 in Bahri localities.

The highest gross margin was recorded in Karrari because it had the highest revenue due to the highest price and highest yield.

The lowest gross margin was recorded in Sharg El Neil due to the lowest price and lowest yield. Another measure of the profitability of the crops is through estimation of the coefficient of private profitability (CPP), which is an important indicator when choosing crops at the producer level (Figure 4-1).

The coefficient of the private profitability was used an indicator to mark production site.

CPP TR/fed

TC/fed

CPP = Coefficient of the private profitability.

TR = Total revenue

TC= Total cost.

If the CPP is less than unity it is unprofitable to produce that product at the present productivity level and/or the present price level.

According to the result in table 4-12 (Figure 4-2 and 4-3), all localities under study were profitable at the producing level since all site had a CPP greater than unity. Hence, when ranking Karrari comes first as it had CPP of about 2.7, it is followed by Bahri with CPP of about 1.96 and finally follows Sharg El Neil locality which had CPP of about 1.3.

Table (4-8): Crop budgets per Feddan for potato in Karrari locality

No	Item	SDG	
1.	Gross value of production yield (ton/fed) 6.25 ton price (SDG/ton) 1786. Gross return (SDG/Feddan) 6.25 x1786		10760.65
2.	Variable costs of production (SDG/fed)		
	Land preparation	159.75	
	Labour cost	800.45	
	Inputs:		
	Seeds	1179.	
	Fertilizers	253.25	
	Pesticides	80.45	
	Land rent	416.66	
	Irrigation	662.75	
	Marketing	430.8	
3.	(Total variable costs production SDG/Feddan)	3983.11	3983.11
4.	Gross margins (SDG/Feddan)		6777.54

Table (4-9): Crop budgets per potato in Bahri Locality:

No	Item	SDG	
1.	Gross value of production yield (ton/fed) 3.73 ton price (SDG/ton) 1606 Gross return (SDG/Feddan) 3.73 x1606		10760.65
2.	Variable costs of production (SDG/fed)		
	Land preparation	151.5	
	Labour cost	563.25	
	Inputs:		
	Seeds	1005.5	
	Fertilizers	350.55	
	Pesticides	59.25	
	Land rent	425	
	Irrigation	306.25	
	Marketing	192.5	
3.	(Total variable costs production SDG/Feddan)	3053.85	3053.85
4.	Gross margins (SDG/Feddan)		2936.53

Table (4-10): Crop budgets per potato in Sharg El Neil Locality:

No	Item	SDG	
1.	Gross value of production yield (ton/fed) 2.84 ton price (SDG/ton) 1536 Gross return (SDG/Feddan) 2.84 x1536		10760.65
2.	Variable cost of production (SDG/fed)		
	Land preparation	164.5	
	Labour cost	584.25	
	Inputs:		
	Seeds	1224.5	
	Fertilizers	258.5	
	Pesticides	49	
	Land rent	375	
	Irrigation	420	
	Marketing	165.8	
3.	(Total variable cost production SDG/Feddan)	3241.55	3241.55
4.	Gross margins (SDG/Feddan)		1120.69

Source: field survey 2007

Table (4-11): Coefficient of private profitability of potato Karrari, Bahri and Sharg El Neil:

Region	TVC (SDG/fed)	TR (SDG/fed)	CPP TR/TC	Gross Margin
Sharg El Neil	3241.55	4362,24	1.3	1120.69
Karrari	3878.95	10760.65	2.7	6777.54
Bahri	3053.8	6990.8	1.96	2936.53

Table (4-12): The respective share of each cost item of the total cost of production for the different sites:

Cost item	Sharg El Neil	Karrari	Bahri
Land preparation	5.1	4.0	5.0
Labour cost	18.1	20.1	18.4
Seeds	37.8	29.6	32.9
Fertilizers	7.7	6.4	11.5
Pesticides	1.5	2.0	2.0
Land rent	11.5	10.5	13.9
Irrigation	13.1	16.6	10.0
Marketing	5.1	10.8	6.3
Total	100	100	100

Source: Field survey 2007

Figure (4-1): The coefficient of private profitability including total revenue and total cost of potato in Karrari, Bahri, and Sharg El Neil:

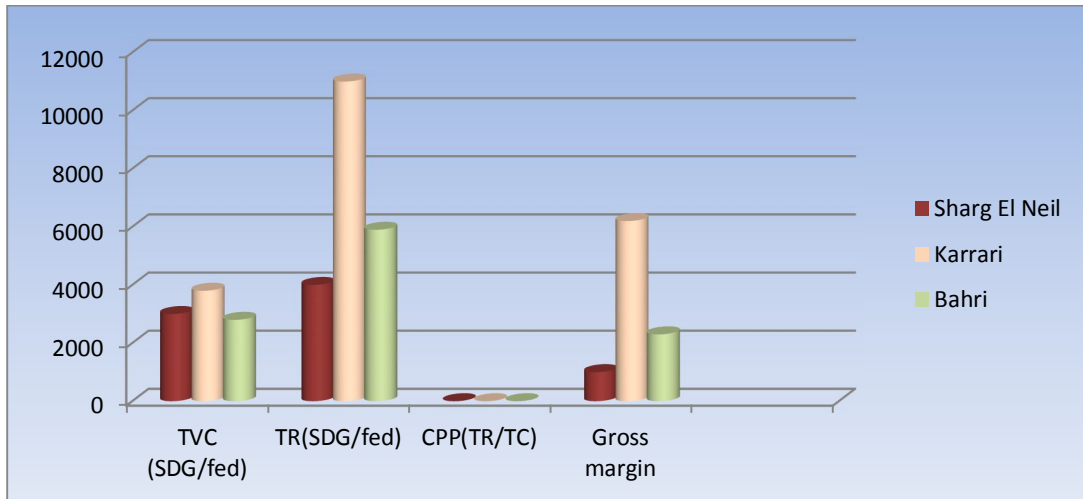


Figure (4-2): The coefficient of private profitability of potato in Karrari, Bahri, and Sharg El Neil:

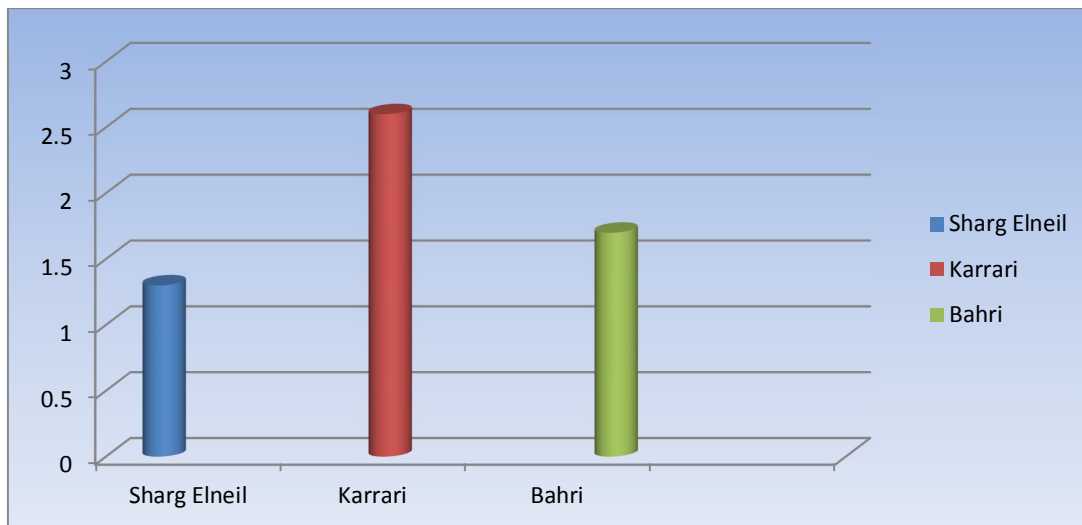
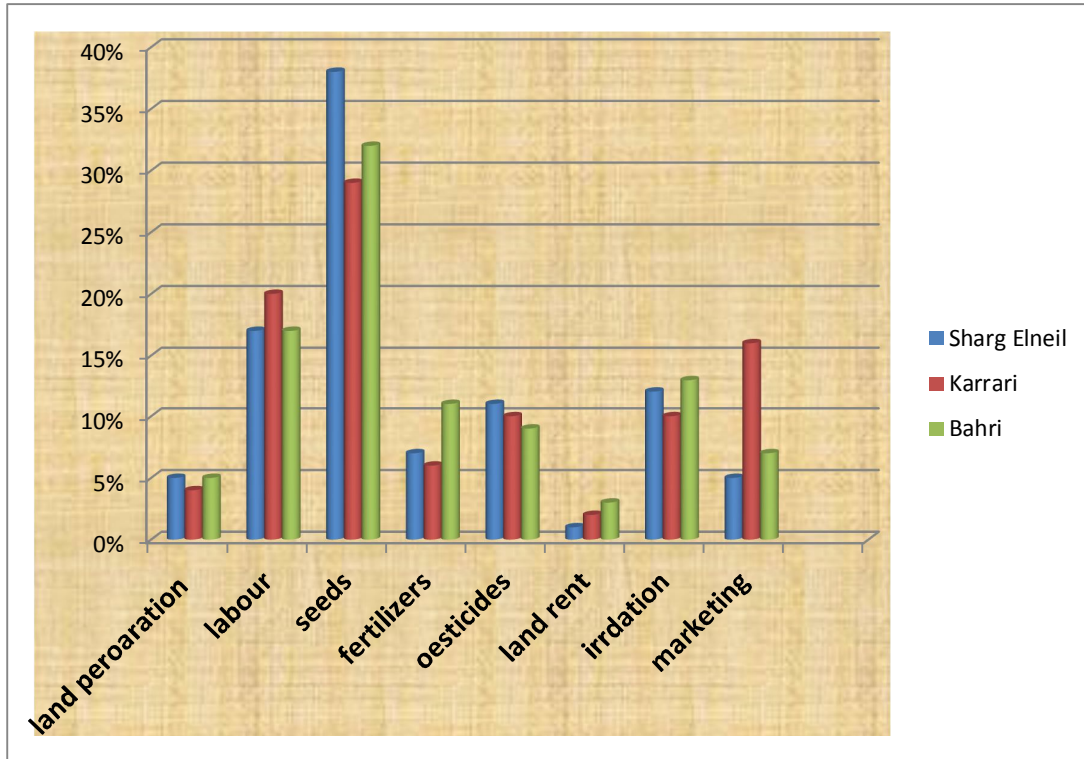


Figure (4-3): The respective share of cost Item of the total cost of production for the different sites:



CHAPTER FIVE

Summary, conclusions and Recommendations

5-1: Summary:

Khartoum state is considered as the main site for growing potato in the country. The study was conducted in Khartoum State season 2005/2006.

The main objective was investigation of the socio- economic characteristics of the farmers, determination of the main cost item, calculation of the gross margins and profitability of the crop in each site of Khartoum state. Primary data was collected by means of questionnaire from a stratified random sample of 60 farmers. 20 farmers were selected from each area, namely Karrari, Sharg Elneil & Bahri. Secondary data was also collected from the Ministry of Agriculture.

The descriptive statistical analysis used revealed that the socio economic characteristics of the farmers were more or less homogenous. More than 75% of the farmers were within the active age group, and only 15% were above 60 years of age.

The level of illiteracy was high amongst the farmers in the survey. About 93% of these farmers had production between 4-3.2 ton/Feddan and income between SDG (70 14-7469).

In the season 2005/2006, about 35% had rented, 3.7% owned and 33.3% both rented and owned.

The study showed that the yield was about (6) ton/Feddan in Karrari, 3.7ton/Feddan in Bahri and 2.8 ton/Feddan in Sharg El Neil.

The average total variable costs of production for potato were found to be about SDG 3268.3/Feddan in Karrari, about SDG 2888.3/Feddan in Bahri and about SDG 3290.7/Feddan in Sharg Elneil.

The analysis of the total variable costs of production revealed that the main cost items in both Karrari and Sharg Elneil were seeds, Labour and irrigation. Whereas, in Bahri the main cost and land rent. Hence, the main cost items in Khartoum state were seeds, Labour and irrigation costs.

The average costs of potato in Karrari were about SDG 1786/ton, Feddan in Bahri about SDG 1606/ton and Sharg Elneil about (1636/ton).

On average the gross cost of potato in Karrari was about SDG 1786/ton, in Bahri about SDG 5990.38/Feddan and in about SDG 4362, 24/Feddan in Sharg Elneil

The crop budgets revealed that average gross margin obtained was about SDG (6777.54/Feddan) in Karrari, SDG (2936.48/Feddan) in Bahri and about SDG(91120.69/Feddan) in Sharg Elneil

The result revealed that the crop was profitable at producer level in all areas in Khartoum state.

Hence, comparing the areas under study according to their coefficient of private profitability indicated Karrari of the highest profitability followed by Bahri then Sharg Elneil.

5-2: Conclusion:

The static analysis of socio-economic characteristics of the farmers showed a homogenous group, since almost all of them were sharing the same characteristics. The analysis of cost structure showed that the main cost items in both Karrari and Sharg Elneil were seeds, Labour and

irrigation. However, the main cost items in Bahri were seeds, labour and land rent. It was found that the crop was profitable at the producer level price . According to ranking of the coefficient of private profitability of the different areas of potato production, in Khartoum State were as follows: Karrari, Bahri and Sharg El Neil, respectively

5-3: Recommendations:

There are number of obstacles that hinder enhancement of potato production. In order to solve these problems, it is recommended that:

- 1- Provide agricultural finance and production inputs at the right time and reasonable prices.
- 2- Improve and strengthen the agricultural extension and farmers education and research programs to rise the sustainability of increased productivity among farmers in the study area. Framers should also be educated and trained about health hazards of pesticides.
- 3- Collaboration of local farmers to join their farming plots together and to combine their efforts through co-operative societies in order to improve agricultural operations.
- 4- A quality variety which is suited to the local environment conditions should be used to improve potato production both qualitatively and quantitatively.
- 5- In order to reduce the Labour cost seeds should be produced locally and advanced agriculture equipment should be employed.
- 6- To use chilled units to transport the potato from farms to the chilled stores. These chilled stores should be well prepared.
- 7- To encourage and develop the industries that depends on potato production such as for example potato crisps and starch.

8- To consider potato as an export product and hence cultivation of the potato variety required in international markets and reduction of production costs to gain a comparative advantage.

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