ECONOMICS OF SWEET MELON
(GALIA CULTIVAR) PRODUCTION
IN THE GEZIRA SCHEME

By

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(May, 2008)
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Date of examination: 17. 5. 2008.
DEDICATION

To my parents whom I adore
To my lovely sister Ekhlas
To my husband Yousif
To my daughter Hind &
Son Mohamed &
All my great family

Entesar
ACKNOWLEDGEMENTS

Throughout my life, my special praise and thanks be to the almighty god, Alla, the all gracious, the all merciful, for his innumerable bounties.

I am greatly indebted to my first supervisor, Dr. Nagat Ahmed Elmoustafa, University of Gezira for her close supervision; close follow up of this work with enthusiasm, diligence, keen interest and patience. I am also indebted to my second supervisor, Prof. Muddathir Ali Ahmed for his valuable comments. I am also indebted to Dr. Abdalla Awad Sidahmed from The National Institute for the Promotion of Horticultural Exports for his invaluable advice. Thanks are extended to the staff of computer and internet room (Miss. Rehab Hasuna and Mrs. Intesar) for typing this thesis. Thanks are also due to the staff of the Department of Agricultural Economics, Faculty of Agriculture, for their sincere co-operation.
Economics of Sweet Melon (Galia Cultivar) Production in the Gezira Scheme

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ABSTRACT

The present study aimed at studying the economics of production of Galia melon by analyzing the returns and cost of production and estimating the relationship between Galia melon productivity and the main variables effecting Galia productivity. Multiple regression analysis using ordinary least squares method was employed for the purpose of estimating and analyzing the impact of the main variables affecting Galia productivity. Descriptive statistics was used for the purpose of analyzing the returns and the cost of productivity of Galia Melon. Both primary data and secondary data was collected. Results obtained showed that Galia production was profitable both for local marketing and export. The highest yield was obtained by farmers who irrigated the crop 8-10 times. Also, results obtained showed that applying fertilizer at distance from the plant was ideal for higher yield. Moreover, growing shelter crops that work as insect repellents proved to increase the productivity of the crop.
اقتصاديات إنتاج القالبا في مشروع الجزيرة

إنصار أحمد عوض الكريم الترابي

لماجستير العلوم في الاقتصاد الزراعي (مايو، 2008م)
قسم الاقتصاد الزراعي
كلية العلوم الزراعية
جامعة الجزيرة

ملخص الأطروحة

تهدف هذه الدراسة إلى دراسة اقتصادية إنتاج محصول القالبا بتحليل تكلفة
الإنتاج والعائد وتقدير العلاقة بين إنتاج القالبا والعوامل الفلاحية المؤثرة عليه. استخدم
طريقة الانحدار الخطي المتعدد لتحليل البيانات كما استخدمت طريقة التحليل الوصفي
لتقييم العائد وتكلفة الإنتاج. أوضحت النتائج أن محصول القالبا مربح في حالة التسويق
المجلي والصادر، كما خلصت النتائج أن أعلى إنتاجية تحصل عليها المزارع هم الذين
قاموا بزي المحصول من 8-10 ربات وضعف السماد بعيدا عن النبات وضرورة زراعة
بعض المحاصيل التي تساعد في مكافحة الحشرات مثل الكراوية والكسيرة.
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CHAPTER ONE
INTRODUCTION

Sudan is the largest country in Africa with an area of about 2.5 million square kilometers, extending from the desert in the north to equatorial forests in the south. The country is blessed with rich natural resources, in terms of vast areas suitable for agriculture. Sudan is characterized by different climatic and vegetation regions. Agriculture is considered to be the mainstay of Sudanese economy, it provides livelihood for about 80% of the population. It accounts for about 75% of gross domestic product and provides most of the raw material for the industrial sector (Abdalla and Omara, 2007).

The vast natural resources of Sudan remain largely untapped. There is enough room for vertical and horizontal expansion in the production of field and horticultural crops to meet local demands and tap world markets to secure needed foreign exchange. In this regard, horticultural sector is potentially capable, if properly exploited to push forward the Sudanese export industry and help to develop the national economy. Presently, horticultural exports represent less than 3% of the foreign earnings, around 80% of which comes from mangoes exported to Saudi Arabia and Gulf states (Baraka, 1998).

Sudan is well suited to be one of the major producers and exporters of banana, onions, potatoes, juices, concentrates and a variety of vegetables including melons, green beans, okra, squashes, green and hot papers and egg plant. At present, vegetables production for export is practiced mainly in Khartoum state and the bulk of the air lifted vegetables comes from Galia melon exported to The Netherlands, Belgium, U.K. and Saudi Arabia. Market studies made
during the past few years in Western Europe and the Gulf indicated that plenty of room exists to increase production and stretch the export season to meet the increasing demand for fresh vegetables in these markets.

Galia melon is a sweet melon hybrid known for its high quality taste and flavour. It was introduced to Sudan during the growing season 1986-87 by the Arab Company for agricultural production and processing. The area under cultivation in that season was only 8.5 ha. After successful seasons, expansion in this new line of production was started. The melons produced were mainly for export to Arab countries and Europe (Baraka, 1998).

Galia melon proved to be a good hard currency earner and as a result became a leading export vegetable from Sudan, (Ministry of Commerce, 1980).

The area under Galia melon cultivation is increasing year after year due to prospects for export and urbanization. Improved cultural practices will result in increasing area, under cultivation and boost production for export.

Galia melon is considered as one of the most important horticultural export crops. It ranks second in importance after mangoes. Many studies indicated that growing Galia for export is economically feasible and therefore, the area under Galia cultivation is increasing year after year. The environmental conditions in Gezira are very conductive for growing Galia and it can be grown in some of the wheat areas. In addition, Galia can help the farmers to increase their returns and can be a welcome addition to crop diversification.
1.1 Problem statement

Production and consumption of melon in Sudan increased steadily since the mid 70s. In the last two decades the export industry flourished and more than 2500 acres, around Khartoum, were grown for export. Sudan melon production was almost entirely dependent on an endless number of land races, characterized, by low productivity and poor quality. However, according to Arab Company for Agricultural and Processing Statistics (1998) area and productivity of Galia fluctuated considerably during the period 1992-1998. In addition, being a new crop, most of the producers have little or no idea about its economic value. Moreover, Galia melon produced for exports requires special treatment regarding marketing functions specially grading, packing and transportation. The efficiency in performing the above functions is crucial for Galia melon in order to compete and meet the exports standards.

1.2 The research objectives

The main objective of this research is to study the economics of production of Galia melon and specifically:

1. To estimate and analyze the cost of production and returns of the crop.
2. To identify and analyze the effect of different variables that affecting the productivity of the crop.
3. To study the local and export marketing for Galia.
4. To raw some recommendations.

1.3 The research methodology
1. Primary data was collected using questionnaire for farmers representing the whole population of farmers growing Galia in the Gezira scheme in Tayba agricultural block during season 2006.

2. Secondary data was collected from different sources mainly: The National Institute for the Promotion of the Horticultural Exports, University of Gezira, Ministry of Agricultural and interviewing of some farmers specialized in Galia.

3. Regression analysis using ordinary least squares method was employed for the purpose of estimating and analyzing the impact of the main variables affecting Galia production.

4. Descriptive statistics was used for the purpose of analyzing the returns and the cost of production of Galia.

1.4 Organization of the study

This thesis contain six chapters:

Chapter one: Talk about introduction of Galia melon, problem statement, research objective and research methodology.

Chapter two literature review: (origin, general morphology, economic and nutritional value, post harvested, grading and packaging, cold storage, transport and … etc).

Chapter three area of study: talk about Gezira Scheme, the horizontal of the Gezira Scheme, climate, soil, production relationship, crop rotation and Gezira Scheme act.

Chapter four marketing and growth in Sudanese horticultural exports: the development in Sudanese horticultural export, collection of the exported products and ..etc.

Chapter five materials and methods: the regression analysis, non linier regression analysis includes and ..etc.
Chapter six results and discussion: return and cost of production of Galia, socio-economic characteristics of the farmers and ... etc.
2.1 Origin and center of diversity

It was reported by Manger, Kyle and Robinson (1978) that Cucumis melo L. originated in Africa and that a tremendous diversity was found within the species. This had led to the naming of many botanical varieties, now called groups, some having only trivial differences from each other and some being given different names in different countries. The following is an attempt by some authors to simplify and at the same time make the groups in C. melo more inclusive:

1- C. melo var. cantaloupe Naud. (Cantaloupe or musk melon). Medium size fruit with netted, warty, or scaly surface, flesh usually orange but sometimes green, flavor aromatic or musky. Fruit dehiscent at maturity, usually andromonoecious.

2- C. melo indorus Naud. Winter melons smooth or winked surface with flesh usually white or green and lacking musky odour, usually larger, later in maturity, and longer keeping than cantaloupe, highly susceptible to virus diseases but a source of resistance to fusarium wilt.

3- C. melo flexousus Naud. Snake melon, synonym of snake cucumber a common name causing confusion and is therefore to be avoided. Fruits are long and slender, used when immature as an alternative to cucumber, Monoecious, probably more tolerant to heat and cold than most other groups.
4- *C. melo* Conomon Mak. Pickling melon, sweet melon small fruit with smooth skin, white flesh, early maturity and usually with little sweetness or flavor.

5- *C. melo* chito and *C. melo* dudain Naud. mango melon, vine peach and other similar name for the former: Pomegranate melon, and Queen Anne’s pocket melon for the latter. Distinction between these two groups is not clear from published description long vines with small leaves, small fruits and monoecious flowering. Resistance to gummy stem blight, watermelon mosaic. and possibly to other virus disease could be found in these groups.

6- *C. melo* momoredica. “phut” or snap melon. Grown in India and other Asian countries and it is distinct from any other group. Flesh is white to pale orange, low in sugar and mealy, the smooth surface of the fruit craks as maturity approaches and the fruit disintegrates when barely ripe.

7- *C. melo* agrestis Naud. Wild type with slender vines and small, inediable fruit. Probably synonymous with *C. melo* callous and *C. melo* trigonus resistance to water melon mosaic has been found in this group, possible source of other resistance.
2.2 General morphology

Whitakar and Davis (1962) reported that *C. melo* is a polymorphous species, flowers staminate, pistillate or perfect, vines monoecious or andromonoecious, stems soft-hairy to glabrous, straight or angled, leaves orbicular or ovate to reniform, usually five-angled, sometimes shallowly three to seven-lobed, hairy or somewhat scabrous, the staminate clustered, the pistillate solitary on short stout pedicels: Fruit exhibiting tremendous variation in size, shape and external appearance, being smooth or sutured, netted or partially netted, at maturity usually yellow-brown, or greenish-yellow.

2.3 Economic and nutritional values

According to Alcazar and Gulick (1983), the total annual areas occupied by melon world wide were estimated to be 419 and 483 thousand hectares during the sixth and seventh decades of last century, respectively. Most of the area under cultivation was localized in the developed countries. In the Sudan, data concerning total annual yield and area under *C. melo* are lacking. Alcazar and Gulick (1983) estimated the nutritive value in hundred grams of the edible portion of a mature melon fruit Table (1). It is clear from Table (1) that melon fruit is rich with mineral vitamins specially vitamin A and C.
Table (1): Nutritive value of a mature melon fruit (in 100 gram edible portion).

<table>
<thead>
<tr>
<th>% refuse</th>
<th>Energy calories</th>
<th>Water gr.</th>
<th>Protein gr.</th>
<th>Fat gr.</th>
<th>CH0 gr.</th>
<th>B1</th>
<th>B2</th>
<th>A</th>
<th>C</th>
<th>Ca</th>
<th>Fe</th>
<th>Niocin</th>
<th>Mg</th>
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<td>41-45</td>
<td>26-41</td>
<td>87-92</td>
<td>0.6-1.0</td>
<td>0.1</td>
<td>6.3-10</td>
<td>0.06</td>
<td>0.02</td>
<td>3000-4200</td>
<td>19-45</td>
<td>5-10</td>
<td>0.2-0.4</td>
<td>4.9</td>
<td>8-17</td>
<td>7-39</td>
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Source: (ALcazar and Gdlick, 1983).
2.4 Cultural practices

Peirce (1987) stated that melon are directly seeded on flat ground or raised. Tindall (1983) reported that the seed rate is 2-4 kg/ha. The normal practice is to sow 1-3 seeds 1-2 cm deep in prepared holes. In row spacing of 30 cm and between row spacing is 1.5-2 m. Melons are not tolerant to poorly drained soils and will quickly wilt and die under conditions of poor drainage (Ware and Mc Colloum, 1975).

Irrigation should be frequent and soil moisture should be maintained at a reasonable level since plant have high demand for water until fruits reach maturity (Tindall, 1983). Careful study and knowledge of soil and weather conditions is necessary for proper irrigation. Care should be taken not to wet the foliage as this would increase the susceptibility to leaf spot disease (Nonneke, 1989).

Melon (*cucumis melo* L.) are annual crops grown in different parts of the world, where frost-free seasons with plenty of sunshine and heat are prevailing. They are grown on a wide range of soils. However, they attain more prolific growth on well drained, sandy or siltyloam soils. Slightly acidic soils (pH of 5.5 to 7.5) are desirable (Nonnecke, 1989). Sufficient soil moisture and relatively dry atmosphere are the major climatic requirements for economic production of melons (Mc Collum, 1975).

2.5 Post harvest operations

These operations include the sorting out, storage and transportation of the products. In addition, the products must be protected from heat and sunlight after removing of the infected, damaged, and misshaped products. This sorting can be done by
machines or manually. Then, the products must be washed, dried and waxed to keep the moisture content of the fruits.

2.6 Grading and packing

After sorting, the products must be graded according to size by hand or by grading machines. The products are then packed in packets that comply with the international market prescriptions. Prescriptions include packing material which is usually made of carton, weight and uniformity of packed products. Packing materials can be made locally, or imported. Sorting, grading and packing can take place in different centers at Wafra and Umdoum (the vegetables and fruits unit) under the supervision of SSMO. The insufficiency and poor efficiency of these centers will cause great damage and loss in the products.

2.7 Cold storage

Cold storage is very important for perishable crops. The product must be stored in refrigerators or in refrigerated chambers, till it can be transported to the air or sea ports. There are cold storage rooms in Arab Company with total capacity of over 1000 tones, Wafra Company, Abu shama (Refrigerated Chambers). Cold stores are very important at the airport specially in case of delay of airplanes.

2.8 Transport

Products have to be transported from producing areas by lorries and trucks. This would involve cost specially when producing areas are far from the ports. Also, transportation to grading and sorting centers, cold stores and to the ports. Products need to be transported.
by cooling trucks to avoid product waste. Transportation to external markets is mainly carried out by planes (both cargo and passengers) through different air companies, in different times. This need coordination between the company and the exporter.

2.9 General melon classification

The family Cucurbitaceae to which melon belongs is a moderately large family of about 130 genera and 900 species (Jeffrey, 1980). Only 30 species of nine genera under this family are cultivated (Esquinas. Alcazar and Gulick, 1983).

According to Jeffrey (1980), the Cucumis melo L. is generally classified as follows:

Family : Cucurbitaceae
Subfamily : Cucurbitoidae
Tribe : Melothaeia
Genus : Cucumis
Subgenus : Melo
Group : Melo
Species : Cucumis melo L.

Taha (1997) suggested grouping of the main sweet melon cultivars in Sudan into the following commercial types:

1. American type: These are mainly characterized by coarse, well developed netting of the mature fruit with good shipping quality, slight sutures and orange fleshes. Examples are Top Net, Hales Best jumbo and PMR5.

2. Charentais type: Cultivars of this group have rounded fruits with high shipping quality and thick flesh. This group includes Nantais oblong, vedrantais, virgos and charentais.
3. Spanish type: Characterized by slight fleshes, very firm fruits, and white to whitish flesh colour, examples are Amarillo and Rochet.

4. Ananas type: Fruits are elongate with medium seed cavity, high TSS, very good flavour and creamy flesh colour.

5. Ogen type: Have rounded fruits, slight to medium stutures, low shipping quality, moderate TSS and good flavour.

6. Galia type: Medium fruit size, with fine netting, thick flesh, high TSS and excellent flavour, green to greenish flesh colour.

7. Indigenous Sudan, types: Having large fruits with large seed cavity, coarse to very coarse netting, deep sutures, low TSS, low flavor and orange fleshes. They are much adapted to the local growing conditions. Example is the line UG 00171 which was collected from White Nile State.
2.10 Economic importance of melon

The main producing countries of melon are China, Turkey, Iran, United States and Spain. China is considered as the leading country in the world for melon production. In the past decade (USDA, 2000), it was found that demand for melon was increasing dramatically worldwide and a low fluctuation in prices was observed. This situation provide a good chance for developing countries to expand their production and exports. Sudan started growing melon for exports in mid of the seventies. Melon production increased in the past decade due to prospects of export to Europe, Arab Gulf and Saudi Arabia. Table (2) shows the total area under cultivation by Galia melon and total yield in the Sudan during the period 1992-1997.

2.11 Yield

Yield per plant was positively correlated to the number of fruits, average fruit weight, number of nodes on the main stem. Erappel (1968) stated that yield per unit area increased with increased plant population until a certain point and then decreased.

2.12 Major pests and diseases affecting Galia in Sudan

Whiteflies, aphids and beetles are among the most economically important insects, which infest many melon crops in the Sudan and cause considerable yield losses either by direct sucking or by transmitting pathogens.

2.13 Whiteflies

The whitefly B. tabaci, is widely spread throughout the world. Due to lack of efficient biological control measures, damage incited by the
small whitish restless flies is dual since they also transmit virus diseases (Boissot et al., 2000).

2.14 Aphids

The cotton aphid, *Aphis gossypii* Glover, is capable of virus transmission of plant viruses such as zucchini yellow mosaic virus (ZYMV), cucumber mosaic virus (CMV) and watermelon mosaic virus (WMV). It causes direct injury to watermelon (Kent, 1989).

2.15 Beetles

Beetles are among the most damaging insect pests to cucurbits in different parts of the world. Feeding by the adult beetles is particularly injurious to seedling. In addition to the direct damage, beetles act as vector of some viral diseases such as squash (Kent, 1989).

**Table (2): Total area under cultivation by Galia melon and total yield in Sudan during the period 1992-1998.**

<table>
<thead>
<tr>
<th>Season</th>
<th>Area/ feddans</th>
<th>Productivity Ton/fed</th>
<th>Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992/93</td>
<td>400</td>
<td>3.000</td>
<td>1200</td>
</tr>
<tr>
<td>1993/94</td>
<td>250</td>
<td>1.13</td>
<td>282</td>
</tr>
<tr>
<td>1994/95</td>
<td>155</td>
<td>5.541</td>
<td>858</td>
</tr>
<tr>
<td>1995/96</td>
<td>410</td>
<td>6.500</td>
<td>2665</td>
</tr>
<tr>
<td>1996/97</td>
<td>850</td>
<td>4.000</td>
<td>2400</td>
</tr>
<tr>
<td>1997/98</td>
<td>900</td>
<td>4.000</td>
<td>3600</td>
</tr>
</tbody>
</table>

Source: Arab Company for Agricultural and Processing 1998.
CHAPTER THREE
AREA OF STUDY

3.1 Gezira scheme

The irrigated sub sector of the Sudan is dominated by the 2.12 million feddans in Gezira irrigated scheme; 1.16 million feddans in the Main Gezira and 0.96 million feddans in the Managil Extension (Plussquelllec, 1990).

The Gezira scheme occupies that part of the clay plain of the Sudan between the Blue and White Niles, north of the Sennar- Kosti Railway. It is delineated approximately by $13^0 30'$ and east longitudes (Siddig and Hughes, 1970). The Gezira scheme is regarded as the largest oldest and most important one within the agricultural sector in general and the irrigated sub sector in particular.

According to the Planning and Socio-Economic Research Unit of SGS the importance of the Gezira scheme to the national economy is documented by the following (SGB, 1994):
- It constitutes about 12% of the total area under crop production in the Sudan, which represents 47% of the total area under irrigation.
- It represents a source of employment to about 7% of the Sudan’s total economically active labour force.
- It provides the livelihood for about 1.5-2.00 millions of the population living in the Gezira area.
- It produces 56% of the Sudan’s total cotton production.
- It contributes about 60% of the Sudan’s total wheat production.
3.2 The historical development of the Gezira scheme

The Gezira irrigation scheme started in 1910 as a pilot farm, mainly for cotton production, at Tayba area 8 kilometers north Wad Medani. The area cultivated with cotton was 250 feddans and the rest of the area, which is the 350 feddans, was cultivated with food crops. The success of Tayba Pilot to about 30 thousand feddans and expansion of the cotton cropped area to reach a maximum of about 21 thousand feddans in 1924/25. During that time new pump stations at Barakat, Hag Abdalla and Wad El Naw were also erected to irrigate a total area of about 69.5 thousand feddans. However, after the completion of the Sennar Dam in 1925, an area of about 300 thousand feddans was brought under irrigation by gravity flow from the Blue Nile. Out of this area, about 80 thousand feddans were devoted for cotton production in the first season this area was increased to about 100 thousand feddans in the second season (Yousif, 1996). Afterwards, the area under gravity irrigation steadily increased to about one million feddans by the early 1950s. In 1962 the area under gravity irrigation was again extended by 800 thousand feddans after the establishment of the Managil Extension area of about 2.12 million feddans by gravity flow from Sennar Dam (Plusquellec, 1990).

The area cultivated with cotton also contributed to the development of the scheme represent about 31% of the total area under crop production in the scheme during the second half of the 1980. During the early 1990s the area cultivated with cotton declined due to the expansion in the production of food crops mainly wheat and sorghum as a result of food security strategy.
3.3 Climate

The climate of the Gezira area is arid and continental with a dry north to northeasterly winds in winter, and a southwesterly winds in summer. The rainy season extends over six months, generally, from May to October with an annual average rainfall between 472mm near Sennar and 160 mm near Khartoum.

The relative humidity fluctuates between 70% during the rainy season and 20% during the dry seasons. The temperature varies from below 20°C in December to over 40°C in May with an annual mean of about 28°C (Plusquellec, 1990).

3.4 Soil

The soils of the Gezira area are classified as vertisols that consist mainly of sediments of the Blue Nile with a clay content of about 50% to 60%, and a high exchange capacity. The Gezira soils are also characterized by aeration, hence resulting in yield reduction (Plusquellec, 1990). According to Eldaw (1985) the soils of the Gezira suit the irrigation by gravity for the following reasons:

- The clay soils of the Gezira allow very little water loss through seepage, hence little investment in canal lining is required.
- The heavy cracking vertisols of the Gezira allow water to reach the plant roots as a result of the swelling and shrinking under wetting and drying.
- The gentle slope of about 15cm of the Gezira plain towards the north and the northwest allow suitable flow of the irrigation water and little investment in levelling.
3.5 Production relations

Gezira scheme is operated according to a triple pattern of parastatal production relations established under the 1913 Gezira tenancy agreement. This agreement has specified the responsibilities of the three partners to be as follows:

Government represented by the Ministry of Irrigation is concerned with the construction and the maintenance of the irrigation network.

The Sudan Production Syndicate which is replaced by the Sudan Gezira Board following the nationalization of the Gezira scheme in 1950, is responsible for the agricultural management of the scheme. This includes administration, technical supervision, provision of social services, accountancy and the tenants who are responsible for the supply of labor and the performance of the field operations.

According to the 1913 Gezira tenancy agreement, a Joint Account System (JAS) was established in the scheme to distribute the net returns from the sales of cotton between the three partners. Under the JAS, each tenant receives his share from the net returns from the sale of cotton according to the number of feddans that he had cultivated with cotton. As such, the more productive cotton producers were at a disadvantage, since there were given net return per feddan similar to that given to the less productive cotton producers. Consequently, and due to the loss of production incentives, the scheme experienced by the late 1970s a sharp decline in yield of the different crops grown in the scheme. By 1980/81, the JAS substituted by Individual Account System to cure the decline in crop yields. The idea was to provide production incentives to tenants through the distribution of the net returns from the sales of cotton according to the number of canters of
cotton delivered after the deduction of the production costs from the tenant’s individual accounts.

3.6 Crop rotation

Gezira was designed with the main objective of producing cotton, as a single cash crop. The cropping pattern and crop rotation in the scheme were determined administratively due to agronomic and policy considerations. Tenants were not free to decide on what to produce and the inputs levels to use. A rotation system was necessary for two reasons: first to conserve soil fertility, and second to prevent the carry over of diseases and pests from one year to the next.

3.7 Gezira Scheme Act (2005)

In part five paragraph (g, f and z) from the act:

- g. Farmers have their rights in managing their production and economic issues considering the technical limitations and using technology to improve productivity and maximize profitability.
- f. Farmers have their rights in effective participation in planning and implementation of projects and programs which affect their production and life at the all management levels.
- z. Farmers have their rights in managing the irrigation operations at field canals levels by water users unitites.
Table (3): Development of crop rotation in Gezira scheme.

<table>
<thead>
<tr>
<th>Season</th>
<th>Rotation</th>
<th>Number</th>
<th>Land use intensity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1925/26-30/31</td>
<td>C-S/L-F</td>
<td>3-Course</td>
<td>66.6</td>
</tr>
<tr>
<td>1931/32-32/33</td>
<td>C-F-F</td>
<td>3-Course</td>
<td>33.3</td>
</tr>
<tr>
<td>1933/34-60/61</td>
<td>C-F-F-C-F-L/F-F-F</td>
<td>8-Course</td>
<td>50</td>
</tr>
<tr>
<td>1961/62-74/75</td>
<td>C-W-F-C-L/G-S-P/F-F</td>
<td>8-Course</td>
<td>75</td>
</tr>
<tr>
<td>1975/76-90/91</td>
<td>C-W-G/S-F</td>
<td>4-Course</td>
<td>75</td>
</tr>
<tr>
<td>1991/92-94/95</td>
<td>C-W-G/S/V-FD-F</td>
<td>5-Course</td>
<td>80</td>
</tr>
</tbody>
</table>

Source: Gezira Rehabilitation Project, Study on Crop Choice Patterns, in the Gezira Scheme (Final Report, March 1994).

C: Cotton; S: Sorghum; F: Fallow; L: Lubia; W: Wheat; P: Phillipesara; FD: Fodder; V: Vegetables; G: Groundnut.
CHAPTER FOUR
MARKETING AND GROWTH OF HORTICULTURAL CROPS EXPORTS IN SUDAN

4.1 Developments in Sudanese horticultural crops exports

As already mentioned, Sudanese horticultural crops exports have expanded to both Arab and European markets. However, the volume, value and prices of these exports as well as the continuity of the exports to the respective countries have been heavily varying from year to year. Thus, the volume, value and prices of some exports undergone severe fluctuations indicating that they have been subjected to factors that induced growth in some years, and factors that induced declines in other years.

4.2 The exporters function

Before the product is exported in the international market, there are various marketing activities that should be performed including grading and packing. These marketing activities differed in terms of their number, quality and cost from one exporter to another.

4.3 Collection of the exported products

Most of the exporters buy the products from the central markets and middlemen. This is a common practice in case of mango which is collected from the producing areas such as Blue Nile, Shendi, Abu Gebeiha by middlemen and sold to exporters, usually by forward sale.
In the case of melons, the exporters used to collect the produce from the farmers (Fig.1).

In addition, many exporters are involved in production especially around Khartoum in Elslait, Suba, Ummdorman and Elsaggai.

Fig. (1): Shows the trade structure of Galia melon in Sudan.
4.4 Quality control

According to Sudanese Standards and Meteorology Organization (SSMO), the quality is defined as the features or characteristics of product or services that bear on its ability to satisfy stated or implied need, specified by the consumer or identified and defined by the producer.

Quality control is the activities and techniques used to assure the fitness of products to quality terms. It is done by officials of the Sudanese Standards and Metrology Organization. These activities include testing and controlling the products at different post harvesting operations (sorting grading, packing). These are specified standards for each exported vegetable and fruit. However, there are general standards for them. Such standards include the following:

- External feature: fruit must be ripe, homogenous, compact, free from any distortion or scratch.
- Ripeness: full ripeness, color concentration, appearance of fruits.
- Pests: free from diseases, pests or their residues.
- Fertilizer and chemicals: fruit must be free from their residues and spots.

The Arab Company for Horticulture Exports has a center at Khartoum Airport, in addition to the previously mentioned centers. After the products have been tested, a certificate on quality and packing will be delivered to the exporter.

4.5 Export standard of melon

Countries exporting melons to European markets must follow the European Economic Community quality standards which specify that the melons must meet the following specifications: fruit must be well
formal sufficiently riped clean and free from foreign smell or taste. Moreover, fruits shape and colour should meet the variety characteristics.

4.6 Classification

Class I: Fruits falling in this class should be free from cracks or bruises (small superficial cracks are not considered as defects). In the varieties where fruits do not slip the pedicel length should not exceed 3cm when harvested.

Class II: This class comprises melons of lower quality compared to those of class I but satisfies the minimum requirements defined above and have the following defects.

- Slight defects in shape.
- Slight degree of discoloration of the rind and the flesh.
- Slight bruises or superficial damage caused mechanically or by parasites or diseases.

4.7 The sweet melon

The variety produced for export is Galia, which is known by its uniformity and sweet flesh. The demand of Galia in European markets is increasing.

Galia is produced in different parts of Sudan. According to Sudanese standards, Galia intended for export have to be fully mature, free of bruises and any sign of deformity. They must be free of pests and diseases. Since Galia is grown in fertile soil, fertilizers and pesticides are rarely applied. In general, Sudan exports sweet melon free of any pesticide residues. According to the standards, the fruit is
classified into three categories on the basis of quality, uniformity and maturity designated by:

AA extra good.
A good.
B medium.

On the basis of size, the exported Galia is classified into three categories:
Large > 1.5kg.
Medium 0.6-0.8kg.
Small < 0.6kg.

Galia is packed in paper cartons bearing all the labels indicating the weight and the grade of the fruit. Sudan ranks number 10 in the international Galia market, and the potential is there for a vast further increase in production (NIPHE, 2006).

4.8 Size

The size is determined by the net weight of the fruit or by diameter. In the same package, weight of the biggest fruit should not exceed by 50% that of the smallest and the diameter of the biggest fruit should not exceed that of the smallest by 20%.

4.9 Tolerance

Quality tolerance:

Class I: At most 10% (by number of melons) not satisfying the requirements for class I is permitted, but meeting the requirements for the class immediately below.

Class II: At most 10% (by number of melons) not satisfying the requirements of class II but fits for local consumption.
4.10 Packaging and presentation

The content of each package must be uniform particularly with respect to variety and class, in addition to quality and size.

4.11 Packaging

(I) The material used inside the package must be new, clean, sufficiently inert and harmless to human health.

(II) The use of materials, particularly papers, bearing and printings is allowed on condition the printed portion does not come into direct contact with the produce and that printing has been done with a non-toxic ink.

4.12 Marking

* Each package must bear the following particulars legibly and indelibly marked on the outside.

* Nature of produce, melon, when the produce is not visible from the outside.

* District of produce, district of origin or national, regional or local trade name.

4.13 Identification

Packer \[\rightarrow\]

Name and address or code mark

dispatcher

4.14 Commercial specifications

A variety, class, size and number of fruits, official control mark (King, 1976).
4.15 Export procedure

Export of a product involves large number of institutions that perform various activities. These institutions include the following:

4.15.1 The financial institutions

They are concerned with policies (macro and micro) and financial supports. These include Bank of Sudan, Ministry of Finance, and other commercial and specialized banks.

4.15.2 The services institutions

They provide services for exports during the different stages. These include Federal Ministry of Agriculture in supervision, organization, extension, and crop protection. Also, air and transport companies provide services.

4.15.3 The controlling institutions

Such as Sudanese Metrology and Standards Organization, plant quarantine office in the airport, customs authority.

4.15.4 Planning organization and supervision institutions

Such as Horticultural Exports Council, Fruit and Vegetable Council (Ministry of Trade).

4.15.5 Research institutions

Include ARC and Universities. All mentioned institution are interrelated and sometimes interfered in their functions. The majority imposes export fees on each consignment.
4.16 Prices

The Department of Foreign Trade of the Ministry of Commerce, determines certain price for each exported product which are called the entrance prices. Exporter can obtain higher than this price. The Ministry can issue export license to exporter according to:
- To export a permissive product which has already been determined.
- The prices obtained are around the entrance prices.

The international prices are very sensitive to quality and prescriptions. Prices are also influenced by supply specially in Arab markets in which, any increase in supply will decrease the prices.
Table (4): Scope of work of quality for exporting of Galia melon.

<table>
<thead>
<tr>
<th>Parties involved</th>
<th>Scope of work</th>
</tr>
</thead>
<tbody>
<tr>
<td>Producers</td>
<td>Fresh fruit production</td>
</tr>
<tr>
<td></td>
<td>Pre-harvest treatment</td>
</tr>
<tr>
<td></td>
<td>Quality control</td>
</tr>
<tr>
<td></td>
<td>Large-scale packaging</td>
</tr>
<tr>
<td>Private and co-operate export or organization</td>
<td>Goods treatment (washing, sorting, etc)</td>
</tr>
<tr>
<td></td>
<td>Packing (with price tags)</td>
</tr>
<tr>
<td></td>
<td>Sales and marking on their own name or behalf of their members</td>
</tr>
<tr>
<td>Marketing board</td>
<td>Goods treatment (washing, sorting, etc)</td>
</tr>
<tr>
<td></td>
<td>Packing goods</td>
</tr>
<tr>
<td></td>
<td>Marking goods with their own name</td>
</tr>
<tr>
<td></td>
<td>Sales and distribution of the complete national production</td>
</tr>
<tr>
<td></td>
<td>Responsibility for all marketing activities for compulsory members</td>
</tr>
<tr>
<td></td>
<td>Sales to certain importers (so-called panelists)</td>
</tr>
<tr>
<td>Fruit companies (plantation)</td>
<td>Fresh fruit production in some cases buying from other producers</td>
</tr>
<tr>
<td></td>
<td>Quality control</td>
</tr>
<tr>
<td></td>
<td>Packaging good for the exporters</td>
</tr>
<tr>
<td></td>
<td>Sale of goods for the exporter in their own to contact importers</td>
</tr>
</tbody>
</table>

Source: Trade of the Ministry of Commerce.
CHAPTER FIVE
MATERIALS AND METHODS

5.1 The regression analysis

Regression analysis is a statistical technique which is concerned with the study of the dependence of one variable or more other variables, the explanatory variables, with the aim of estimating and/or predicting the mean value of the former based on the known or fixed values of the latter, by expressing the regression model which denotes the relationship between two kinds of variables as stated by Gujarati (1988).

Regression analysis is divided into two main categories according to the number of variables that are involved in the regression model and the form underlying the relationship between the dependent and the explanatory variables of the regression model. The regression analysis include both, linear and non-linear regression analysis.

5.1.1 Linear regression

Linear regression analysis involves a linear form of the relationship between the dependent and the explanatory variables of the regression model. Linear regression analysis includes both simple and multiple linear regression.
a. Simple linear regression analysis

It is the basic form of regression analysis. It constitutes two kinds of variables, the dependent variable and independent variable. It is simple and practically adequate. The simple linear regression takes the following formula:

\[ Y = a + BX \quad \ldots \ldots \ldots (5.1) \]

Where:

- \( Y \) = dependent variable.
- \( a \) = the intercept.
- \( X \) = independent variable.
- \( B \) = regression coefficient (the slope of the regression analysis).

b. Multiple linear regression analysis

It is an extension of the simple regression analysis, but the dependent variable here depends on two or more explanatory variables. Inclusion of other variables influencing the dependent variable in multiple regression is for two reasons:
1- To reduce stochastic error, therefore increasing the strength of statistical tests.
2- Eliminate bias that might result from ignoring an uncontrolled variable that substantially affects the dependent variable.

The general form of the multiple regression function can be written in the following form:

\[ Y = a + B_1X_1 + B_2X_2 + \ldots + B_nX_n + U_i \quad \ldots \ldots \ldots \ldots \ldots \ldots \ldots (5.2) \]

Where:

- \( Y \) = dependent variable.
- \( a \) = the intercept.
B_1,..,B_n = partial slope coefficients.

U_i = error or disturbance term (it is the deviation of Y_i from its expected value).

i = ith observation.

n = variable number.

5.1.2 Non linear regression analysis includes:

- The simple non linear regression analysis.
- The multiple non linear regression analysis.

The non linear regression analysis involves a non-linear form relationship between two kinds of variables of the regression model such as Cobb-Douglas production function.

The Cobb-Douglas production function is regarded as one of the most popular statistical forms that have been well established in the production theory (Stokes, 1979). Gujarati (1988) stated that the very interesting property behind the popularity of the use of Cobb-Douglas production statistical form is that the estimated regression coefficients will directly give the elasticity of output with respect to the inputs used.

The mathematical expression can be put into stochastic form as stated by Gujarati (1988).

\[
Y = B_0 X_i^{B_i} e^{u_i} \quad \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldOTS
The non-linear relationship between Y and X, that is assumed in the expression can be converted into a linear one using a suitable log transformation (Gujarati, 1988). As such the resulting model will be:

\[ \text{Lny} = \text{LnB}_0 + B_i \text{LnX}_i + U_i \]  

\[ \text{......................... (5.4)} \]

\( \text{Ln} \): is the natural logarithm that is the log to the base e.

5.1.3 The variables of the regression model

There are two kinds of the regression variables, these are:

1- The endogenous or internal variables.
2- The exogenous or external variables.

The exogenous variables are the output of the regression models, they are also termed the dependent variables because their values depend on the values of the endogenous variables that are the input of the regression model, and they help to explain the behaviour of the exogenous variables, hence known the explanatory variables as stated by Stokes (1979).

The dependent and the explanatory variables of the regression models are assumed to have two characteristics; these are:

i) The dependent variable (y) tends to vary with the explanatory variables (X's) in a consistent and systematic fashion.

ii) The relationship between the dependent variable (y) and the explanatory variables (X's) is not perfect or precise; that is to say, there is a variation between the observed data and the theoretical values obtained from the regression model as stated by Mill (1977).
5.1.4 The measurement of the parameters of the linear regression model

In the regression analysis, the estimation of the parameters of the regression model, the $B_i$'s, will be based on sample information. Therefore, a sample counterpart or an estimate of the true regression model should be constructed.

One of the most powerful methods that is widely used in the construction of the simple regression models is the methods of the ordinary least-squares. These methods utilize the least-square principle or criterion which states that, the estimates of the parameters of the true regression model should be selected in such a way that will provide the smallest or the minimum sum of squared deviations or residuals from the true regression model. As such, the constructed sample regression model will be the best approximation of its true counterpart (Mill, 1977; Gujarati, 1988).

5.1.5 The estimated regression coefficients

In case of using the Cobb-Douglas statistical form as a functional form for the regression models, the estimated regression coefficients, that is, the exponents of the Cobb-Douglas statistical form, will directly give the elasticity of output with respect to input used that is the percentage change in output owing to one percent change in inputs used (Gujarati, 1988).

According to Stokes (1979), these coefficients can also be used to indicate the marginal productivity of the inputs used, that is the change in the output for a unit change in the level of inputs used. The greater the coefficient the more productive is that input.
5.2 The multiple coefficient of determination (R\(^2\))

According to Gomez and Gomez (1984) and Gujarati (1988), the multiple coefficient of determination (R\(^2\)), measures the proportion of the total variation in the dependent variable (y) explained by the linear function of the explanatory variables (X's) of the regression model. It is regarded as a measure of the goodness of fit since it shows how well the constructed model fits the data. Symbolically, the multiple coefficients of determination (R\(^2\)) is expressed as:

\[
R^2 = \frac{RSS}{TSS} = 1 - \frac{ESS}{TSS}
\]

Where:

\[R^2\] = The coefficient of determination.

\[RSS\] = Is the explained sum of squares-which represents the variation in (y) due to regression.

\[TSS\] = Is the total sum of squares, which represent the total variation in (y).

\[ESS\] = Is the error sum of squares.

The value of R\(^2\) falls in the range between zero, which means no linear relationship between the dependent and the explanatory variables and one which means a perfect fit.

In practice, it is better to use the adjusted R\(^2\) rather that R\(^2\) particularly when the number of the explanatory variables is not very small compared with the number of the observations. The term adjusted indicates adjusted for the degrees of freedom associated with the sums of squares entering in the model R\(^2\) = RSS/TSS = 1 - (ESS/TSS) (Gujarati, 1988).
5.3 Tests of significance

According to Gujarati (1988), the analysis of variance provides an approach to test the overall significance of an observed multiple regression using the F-test. The F-test provides a test of significance of the multiple coefficient of determination ($R^2$). Gomez and Gomez (1984), stated that the coefficient of multiple determination can be regarded as significantly different from zero if the computed F-value is greater than or equal to the corresponding tabular F-value at the prescribed level of significance.

5.4 Testing the significance of the regression coefficients

The T-test is used as an approach to test the significance of the individual regression coefficients. The regression coefficient is said to be significant if the computed T-value is greater that or equal to the corresponding tabular T-value. In this study, the computed F-value and the T-value will be provided directly from the computer.

5.5 The model

This research was conducted in Gazira scheme. The size of respondents was equal to 40 farmers representing 100% of the farmers growing Galia in the Gezira scheme during season 2006. Data was collected using a questionnaire where information related to the objective of the study was administrated and data obtained was analyzed using statistical package for social science (SPSS).

For the purpose of estimating the relationship between Galia productivity and the main explanatory variables we used the following specification:
\[ Y = a + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 \] .......................... (5.5)

Where:

- \( Y \) = Dependent variable (productivity).
- \( X_1 \) = No. of irrigations.
- \( X_2 \) = Fertilizer application
- \( X_3 \) = Shelter crops.
- \( X_4 \) = Harvesting dates.
- \( B_1 \ldots B_4 \) = Regression coefficients to be estimated.
- \( a \) = The intercept.
CHAPTER SIX
RESULTS AND DISCUSSION

This chapter consists of four sections in section (1) we discuss results related to the analysis of the returns and cost of production of Galia melon. Section (2) presents the analysis of the socio-economic characteristics of farmers in relation to Galia production. In section (3) we discuss the distribution of farmers according to the application of each of the variables assumed to affect Galia productivity. Section (4) is devoted to the analysis and discussion of the result obtained by estimating the relationship between Galia productivity and the main explanatory variables.

6.1 Cost and Returns of Production of Galia

Tables (5 and 6) show the cost of production of Galia melon. It is clear from the Table that the items that had the largest contribution to total cost were cartons and seeds. As we mentioned earlier high quality of packing material is required for export purposes. The packing cost amounted to (37%), (38%) and (36%) during the years (2003), (2004) and (2005) respectively. This might be explained by the fact that cartons were imported. The cost of seed represents (45%), (46%), (43%) of the total cost for the years (2003), (2004) and (2005), respectively. This might be attributed to the fact that seeds are imported to ensure the good quality since local farmers have no experience in producing good quality seeds.
Table (5): Cost of production of Galia melon (fed) SD in Gezira (2003-2005).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Land preparation</td>
<td>7000</td>
<td>5</td>
<td>8000</td>
<td>6</td>
<td>9000</td>
<td>6</td>
</tr>
<tr>
<td>Seeds</td>
<td>55000</td>
<td>45</td>
<td>60000</td>
<td>46</td>
<td>65000</td>
<td>43</td>
</tr>
<tr>
<td>Material used</td>
<td>24000</td>
<td>20</td>
<td>24400</td>
<td>18</td>
<td>30000</td>
<td>20</td>
</tr>
<tr>
<td>Labour</td>
<td>13000</td>
<td>11</td>
<td>14000</td>
<td>11</td>
<td>17500</td>
<td>11</td>
</tr>
<tr>
<td>Harvesting operation</td>
<td>10000</td>
<td>8</td>
<td>11000</td>
<td>8</td>
<td>15000</td>
<td>10</td>
</tr>
<tr>
<td>Land and water charges</td>
<td>13000</td>
<td>11</td>
<td>14000</td>
<td>11</td>
<td>15000</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>122000</strong></td>
<td><strong>100</strong></td>
<td><strong>131400</strong></td>
<td><strong>100</strong></td>
<td><strong>151500</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>


Table (6): Total cost for exported (SD) portion of yield (2003-2005).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Land preparation</td>
<td>3818</td>
<td>4267</td>
<td>4846</td>
</tr>
<tr>
<td>Seeds</td>
<td>30000</td>
<td>32000</td>
<td>35000</td>
</tr>
<tr>
<td>Material used</td>
<td>13091</td>
<td>13013</td>
<td>16154</td>
</tr>
<tr>
<td>Labour</td>
<td>7091</td>
<td>7467</td>
<td>9423</td>
</tr>
<tr>
<td>Harvesting operation</td>
<td>5455</td>
<td>5867</td>
<td>8077</td>
</tr>
<tr>
<td>Land and water charges</td>
<td>7091</td>
<td>7467</td>
<td>8077</td>
</tr>
<tr>
<td>Transport (export)</td>
<td>15000</td>
<td>15000</td>
<td>20000</td>
</tr>
<tr>
<td>Grading and sorting out</td>
<td>10000</td>
<td>6500</td>
<td>7500</td>
</tr>
<tr>
<td>Carton</td>
<td>60000</td>
<td>64000</td>
<td>70000</td>
</tr>
<tr>
<td>Cold storage</td>
<td>13000</td>
<td>14000</td>
<td>15000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>164546</strong></td>
<td><strong>169581</strong></td>
<td><strong>194077</strong></td>
</tr>
</tbody>
</table>

Table (7): Share of locally marketed produce (SD) (2003-2005).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Land preparation</td>
<td>3182</td>
<td>6</td>
<td>3733</td>
<td>6</td>
<td>4154</td>
</tr>
<tr>
<td>Seeds</td>
<td>25000</td>
<td>42</td>
<td>28000</td>
<td>43</td>
<td>30000</td>
</tr>
<tr>
<td>Material used</td>
<td>10909</td>
<td>19</td>
<td>11387</td>
<td>18</td>
<td>13846</td>
</tr>
<tr>
<td>Labour</td>
<td>5909</td>
<td>10</td>
<td>6533</td>
<td>8</td>
<td>8077</td>
</tr>
<tr>
<td>Harvesting operation</td>
<td>4545</td>
<td>7</td>
<td>5133</td>
<td>10</td>
<td>6923</td>
</tr>
<tr>
<td>Land and water charges</td>
<td>5909</td>
<td>10</td>
<td>6533</td>
<td>8</td>
<td>8077</td>
</tr>
<tr>
<td>Transport (domestic)</td>
<td>3500</td>
<td>6</td>
<td>3500</td>
<td>6</td>
<td>4500</td>
</tr>
<tr>
<td>Grading and sorting out</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Carton</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cold storage</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>58954</strong></td>
<td><strong>64819</strong></td>
<td><strong>75577</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Own calculation based on data from (NIPHE) (2003-2005).
Table (8): Total yield, gross returns and net returns (fed) of Galia melon produced for export and local consumption in Gezira (2003-2005).

<table>
<thead>
<tr>
<th>Year</th>
<th>Average yield (ton/fed)</th>
<th>Exportable yield (ton/fed)</th>
<th>Locally marketable yield (ton/fed)</th>
<th>Price for export (SD/fed)</th>
<th>Local price (SD/fed)</th>
<th>Gross export returns (SD/fed)</th>
<th>Gross domestic returns (SD/fed)</th>
<th>Export cost (SD/fed)</th>
<th>Domestic cost (SD/fed)</th>
<th>Net export returns (SD/fed)</th>
<th>Net domestic returns (SD/fed)</th>
<th>Total net returns of Galia (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>5.5</td>
<td>3</td>
<td>2.5</td>
<td>100.000</td>
<td>20.000</td>
<td>300.000</td>
<td>50.000</td>
<td>164546</td>
<td>58954</td>
<td>135454</td>
<td>-8954</td>
<td>126500</td>
</tr>
<tr>
<td>2004</td>
<td>6</td>
<td>3.2</td>
<td>2.8</td>
<td>110.000</td>
<td>25.000</td>
<td>352.000</td>
<td>70.000</td>
<td>169581</td>
<td>64819</td>
<td>182419</td>
<td>5181</td>
<td>187600</td>
</tr>
<tr>
<td>2005</td>
<td>6.5</td>
<td>3.5</td>
<td>3.0</td>
<td>120.000</td>
<td>30.000</td>
<td>420.000</td>
<td>90.000</td>
<td>194077</td>
<td>75577</td>
<td>225923</td>
<td>14423</td>
<td>240346</td>
</tr>
</tbody>
</table>

Table (8) shows that the average yield for the 2003, 2004, and 2005 was equal to 5.5 ton, 6 ton and 6.5 tons, respectively. It is clear from the table that there was an annual increase in local and export price. However, local prices were 20%, 23% and 25% of the export price for seasons 2003, 2004, and 2005, respectively. It is clear from table (6) that the cost of Galia produced for export was much higher than domestic cost, however, net returns of export was higher. This might be explained by the high gross returns out of exports due to high export prices. It is observed that the higher the percentage of yield meeting the exports standards the higher the expected returns. From the above results, we concluded that growing Galia is economically feasible and more area can be devoted to its production to ensure greater returns for farmers resulting in higher welfare levels, however, meeting the exports standards is a major constraint to Galia produced for export.

6.2 Socio-economic characteristics of the farmers

6.2.1 Age

Table (9) shows the distribution of farmers according to age. It is clear from the table that the age of 55% of the farmers ranges between 40 and 60 years, which indicate that they are within the productive age.

Table (9): Distribution of the tenants according to the age group.

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Frequency</th>
<th>Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-30</td>
<td>6</td>
<td>15.0</td>
</tr>
<tr>
<td>31-40</td>
<td>7</td>
<td>17.0</td>
</tr>
<tr>
<td>41-50</td>
<td>11</td>
<td>27.5</td>
</tr>
<tr>
<td>51-60</td>
<td>11</td>
<td>27.5</td>
</tr>
<tr>
<td>61-70</td>
<td>5</td>
<td>12.5</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Source: Author calculations.
6.2.2 Education

Table (10) illustrates the distribution of tenants according to education level, the survey showed that about 7.5% out of the sampled tenant studied Khalwa, 40% primary school. About 17.5% are holders of secondary school certificates, while 10% are university graduates. This result reflected that the majority of Galia farmers are educated which allow them to accept the new idea of growing Galia.

Table (10): Distribution of the tenants according to the education level.

<table>
<thead>
<tr>
<th>Education level</th>
<th>Frequency</th>
<th>Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khalwa</td>
<td>3</td>
<td>7.5</td>
</tr>
<tr>
<td>Primary</td>
<td>16</td>
<td>40.0</td>
</tr>
<tr>
<td>Intermediate</td>
<td>6</td>
<td>15.0</td>
</tr>
<tr>
<td>Secondary</td>
<td>7</td>
<td>17.5</td>
</tr>
<tr>
<td>University (above)</td>
<td>8</td>
<td>20.0</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Source: Author calculations.
6.2.3 Occupation

It is clear from Table (11) that 82.5% of the sampled farmers practice agriculture while only 10% are horticultural specialists. The above results indicated the importance of extension, bearing in mind that horticultural production requires some experience.

Table (11): Distribution of the tenants according to the occupation.

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Frequency</th>
<th>Percent (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmers</td>
<td>33</td>
<td>82.5</td>
</tr>
<tr>
<td>Horticulture specialist</td>
<td>4</td>
<td>10.0</td>
</tr>
<tr>
<td>Others occupation</td>
<td>3</td>
<td>7.5</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Source: Author calculations.
6.2.4 Problems of Galia production

According to farmers the main problem facing Galia production in Gezira scheme are finance and marketing for exports.

6.3 Independent variables

As we mentioned earlier the productivity of Galia is assumed to be affected by a number of variables in what follows we discuss the distribution of farmers according to the application of each of the explanatory variables assumed to affect Galia productivity.

6.3.1 Number of irrigation (X₁)

The number of irrigation plays an important role in Galia production. It is clear from Table (12) that about 35% of the farmers irrigated the crop 8-10 times. They obtained an average yield of 5.5 ton/fed, and about 65% irrigated the crop more than 10 times and obtained 4.0 ton/fed. The above result indicated that there is a strong relationship between the number of irrigations and productivity, however, the highest yield was obtained by those who irrigated the crop 8-10 times.

**Table (12): Distribution of the tenants according to the number of irrigation.**

<table>
<thead>
<tr>
<th>No. of tenants</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Average</th>
<th>Std.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yield (ton)</td>
<td>Yield (ton)</td>
<td>Yield (ton)</td>
<td>Yield (ton)</td>
</tr>
<tr>
<td>8-10 irrigation</td>
<td>2</td>
<td>9</td>
<td>5.5</td>
<td>1.54</td>
</tr>
<tr>
<td>More than 10</td>
<td>2</td>
<td>6</td>
<td>4.0</td>
<td>1.25</td>
</tr>
</tbody>
</table>

Source: Author calculations.
6.3.2 Fertilizer application ($X_2$)

As it is clear from table (13) that the position of fertilizer on soil affects Galia productivity. The table shows that 65% of farmers put the fertilizer away from the plant and obtained an average yield of 5.5 ton/fed compared with 35% of farmers who put fertilizer close to the plant and obtained 4.0 ton/fed. It's obvious that the farmer who put the fertilizer far away from the plant obtained higher yield compared with the others. And this is due to that the high concentration of fertilizer close to plant delay its growth.

Table (13): Distribution of the tenants according to fertilizer application.

<table>
<thead>
<tr>
<th>No. of tenants</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Average</th>
<th>Std.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yield (ton)</td>
<td>Yield (ton)</td>
<td>Yield (ton)</td>
<td>Yield (ton)</td>
</tr>
<tr>
<td>Near the plant</td>
<td>2</td>
<td>6</td>
<td>4.0</td>
<td>1.54</td>
</tr>
<tr>
<td>Faraway to plant</td>
<td>4</td>
<td>9</td>
<td>5.5</td>
<td>1.28</td>
</tr>
</tbody>
</table>

Source: Author calculations.
6.3.3 Shelter crops ($X_3$)

From Table (14), about 45% of farmers prefer to grow shelter crops like pigeon pea to avoid insects or to stop the wind and caraway to attract insects, so as to resist them by chemical or organic system, and colander to use this as insects repellent, this obtained an average high yield 5.5 ton/fed, and about 55% of farmers don't using shelter crops and obtained an average yield of about 4.0 ton/fed. It is obvious that farmers who grew shelter crops obtained higher yield compared to those who did not.

**Table (14): Distribution of tenants according to the shelter crops.**

<table>
<thead>
<tr>
<th>No. of tenants</th>
<th>Minimum Yield (ton)</th>
<th>Maximum Yield (ton)</th>
<th>Average Yield (ton)</th>
<th>Std. Yield (ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No shelter Shelter (pigeon Pea, caraway, colander)</td>
<td>2</td>
<td>6</td>
<td>4.0</td>
<td>1.54</td>
</tr>
<tr>
<td>Shelter (pigeon Pea, caraway, colander)</td>
<td>2</td>
<td>9</td>
<td>5.5</td>
<td>1.28</td>
</tr>
</tbody>
</table>

Source: Author calculations.
6.3.4 Harvesting date ($X_4$)

The harvesting date of Galia affects Galia productivity. The results in Table (15) showed that tenants who harvested the crop during November obtained an average yield of 7 ton/feddan. Some of them harvested in December and they obtained 6.0 ton/feddan. Those who harvested during October obtained 5.5 ton/feddan. This means that there is strong relationship between harvesting date and the productivity. The proper time to harvest Galia is during November, where maximum yield was obtained.

Table (15): The effect of harvesting date on Galia yield.

<table>
<thead>
<tr>
<th></th>
<th>Minimum Yield (ton)</th>
<th>Maximum Yield (ton)</th>
<th>Average Yield (ton)</th>
<th>Std. Yield (ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>4</td>
<td>5</td>
<td>4.5</td>
<td>1.50</td>
</tr>
<tr>
<td>Feb</td>
<td>2</td>
<td>6</td>
<td>4.0</td>
<td>2.08</td>
</tr>
<tr>
<td>March</td>
<td>4</td>
<td>5</td>
<td>4.5</td>
<td>0.71</td>
</tr>
<tr>
<td>Sep.</td>
<td>4</td>
<td>5</td>
<td>4.5</td>
<td>0.58</td>
</tr>
<tr>
<td>Oct.</td>
<td>5</td>
<td>6</td>
<td>5.5</td>
<td>0.71</td>
</tr>
<tr>
<td>Nov.</td>
<td>7</td>
<td>7</td>
<td>7.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Dec.</td>
<td>3</td>
<td>9</td>
<td>6.0</td>
<td>1.55</td>
</tr>
</tbody>
</table>

Source: Author calculations.
6.4 Results of regression analysis

Applying OLS technique to equation (5.5), we obtained the following estimated equation:

\[ Y = 2.561 + 0.881 X_1 + 1.853 X_2 + 0.923 X_3 + 0.122 X_4 \]

\[ (1.241) \quad (1.91) \quad (3.93) \quad (2.11) \quad (2.71) \]

\[ R^2 = 0.472 \quad F\text{-value} = 3.578 \]

Figures between brackets are T-statistics of the estimated regression coefficients.

It is clear from the equation above that the explanatory variables of the specified model explain 47% of the variations in Galia productivity according to regression results in Table (16) the P values indicated that all the coefficients are significance.

6.5 Discussion of the regression results

The estimated coefficient of each explanatory variable will be discussed separately to show its influence on Galia production.

6.5.1 Number of irrigation (X_1)

The result of regression analysis showed that 8-10 times of irrigation has a great effect on Galia yield. It has a coefficient of 0.9 indicating that irrigating the crop 8-10 times would lead to 0.9 increase in Galia yield which is significant at 90% level of significant.

6.5.2 Fertilizer application (X_2)

Fertilizer application (continuous variable) is an important factor affecting Galia yield. The result of the regression analysis showed that the fertilizer application, namely the position of fertilizer on the soil,
had a coefficient of 1.9, which is significant at 95% level of significance. The result indicated that when we put the fertilizer far away from the plant, we increase the yield by 1.9 ton/fed. This might be explained by the fact that Galia crop has extended roots which absorbed fertilizer slowly.

6.5.3 Shelter crops (X₃)

The regression result showed that shelter crops increased yield significantly. The regression coefficient for shelter crops is equal 0.9 which is significance at 90% level of significant indicating that the use of shelter crops would increase yield by 0.9 ton/fed.

6.5.4 Harvesting date (X₄)

The result of regression analysis showed that harvesting in November has a coefficient equal to 0.12 which is significant at 95% level of significance indicating that harvesting in November would lead to an increase of 0.12 ton/fed.
Table (16): Regression of results of factors affecting Galia yield.

<table>
<thead>
<tr>
<th>Factors</th>
<th>Coefficient</th>
<th>T-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>2.561</td>
<td>1.242</td>
<td>2.225</td>
</tr>
<tr>
<td>Number of irrigation ($X_1$)</td>
<td>0.991</td>
<td>1.908</td>
<td>*0.081</td>
</tr>
<tr>
<td>Fertilizer application ($X_2$)</td>
<td>1.9853</td>
<td>3.925</td>
<td>**0.001</td>
</tr>
<tr>
<td>Shelter crops ($X_3$)</td>
<td>0.923</td>
<td>2.106</td>
<td>**0.044</td>
</tr>
<tr>
<td>Harvesting date ($X_4$)</td>
<td>0.122</td>
<td>2.710</td>
<td>**0.011</td>
</tr>
</tbody>
</table>

F-value = 3.578
F-sig. = 0.000

$R^2 = 0.472$
Adjusted $R^2 = 0.430$

Source: Author calculations.
* Significant at 90%.
** Significant at 95%.
6.6 Summary

Galia is grown in Gezira scheme by tenants whose tenancies are located near the mouth of the field outlet pipe. In every 90 feddans there are about 16 feddan eligible for vegetable growing. However, some well-to-do tenant may grow Galia which is a capital intensive crop. The seed alone accounts for more than 45% of the cost of production which reaches more than 122 thousand Sudanese Dinnar.

Galia export is another story. The cost of marketing accounts for more than 59% of the total cost and each Dinnar of the cost contributes about 1.82 Dinnar or 82% of net return. The probability of exported Galia may increase significantly if certain cost items of marketing could be reduced mainly the containers which account for 61% of the marketing cost.

The production per feddan average for the last three years (2003/2005) about six tons of which 3.2 tons or 53% are exported and the remaining portion is locally marketed. The local prices are one fifth of the export price while the net return of locally marketed crop accounts for 2.3% of the net exported ton which fetches SD 56061.3. From the above analysis it is clear that Galia production is very risky unless being exported farmers who have meagere capabilities should not indulge in Galia production.
RECOMMENDATIONS

1. Increase in productivity of Galia through provision of improved seeds and adoption of recommended package by research centers.

2. To upgrade farmers skill in grading and packaging of Galia.

3. Local production of carton produce packaging cost.

4. More research work is needed to produce high yielding varieties suitable for Sudan conditions.
CONCLUSIONS

- Galia cultivation is profitable both for local marketing and export.
- Galia productivity is significantly affected by numbers of irrigation, position of fertilizer, shelter crops and harvesting date.
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