The Economics of Agricultural Labour Markets in Sudan: A Case Study of Gezira Scheme

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A Thesis Submitted to the University of Khartoum in Fulfillment of the Requirement for the Degree of Doctor of Philosophy in Agriculture

Department of Agricultural Economics
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December 2006
DEDICATION

Affectionately dedicated to the Soul of my father.

To my Mother, Brothers, Sisters and their kids.

To my beloved family.
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ACKNOWLEDGEMENT

First of all I thank Allah for having given me the health, strength and patience to accomplish this work.

I would like to express my deepest gratitude to my supervisor Professor Babiker Idris Babiker for his advice, constructive guidance and valuable support throughout the course of this study.

Genuine appreciation is extended to Professor Doctor Siegfried Bauer (University of Giessen, Germany) for his invaluable aid and support during my research stay in Germany. In this regard I would like to extend my appreciation and thanks to the German Academic Exchange Service (DAAD) for the provision of the financial support to this work. During my stay in Germany, my deepest thanks are hopefully due to my friends Doctor Victor (Ghana), Doctor Joshi (Nepal), the group of the students from developing countries and to my friends from Sudan Tarig, Ala El-Deen, Khalid and El-Gali and their families.

My sincere thanks are due to my friends Doctor Salah Dafalla, Doctor Mohammed El-Amin Ali, Doctor El-Sadig Agbna and all colleagues and friends.

Thanks are extended to the planning and Socio-economic Research Unit, the Sudan Gezira Board for their help during the data collection. Also the assistance and cooperation of Shambat Library Staff is appreciated with thanks.

My deepest thanks and appreciations are due to the teaching staff, the clerical staff and my colleagues in the department of
Agricultural Economics, Faculty of Agriculture, University of Khartoum for their encouragement and support.

I would like to express my honest gratitude and regards to my family for their kind and enthusiastic support throughout my study.

Finally, the efforts of all who helped in a way or another are gratefully acknowledged.
ABSTRACT

The main objective of this study is to analyze some economic aspects of the agricultural labour market in irrigated agriculture with reference to Gezira Scheme, which may help in drawing some soundly based policy implications.

The analytical techniques used to test for the study hypotheses are; descriptive statistics, the Cobb-Douglas production function, other econometric analysis such as multiple and Tobit regressions. Then, based on household theory, a quantitative farm household model was developed using non-linear programming. The study depends mainly on primary data which have been collected by means of a structured questionnaire and direct interviewing with the Gezira tenants who grew cotton, wheat, sorghum and groundnut crops for the season 2003/2004. Also, necessary secondary data have been used. A multi-stage stratified random sample of 150 respondents was selected. As well a sample of 60 respondents was selected from the hired workers in Gezira Scheme.

The descriptive analysis revealed that the farmers are a homogenous group, the majority of them are within the productive age group and their average family size was an indicative of large potential labour force. The analysis of the socio-economic characteristics of the agricultural workers revealed that they were young; on average and regarding their source they could be either seasonal, local or labour from camps who prefer to work as sharecroppers with the tenants than to work as hired labourers. The descriptive analysis of some related aspects to the rural labour
markets in Gezira Scheme assured the existence of some non-
market institutions such as sharecropping practices. Also it was
observed that the interviewed tenants tried to diversify their
income sources and there were some reported cases of internal and
external migration among the tenants’ households.

Generally, the production function analysis showed that
factors of labour and average cost of variable inputs (proxy for
capital) were found to be of utmost importance for the production
of the studied crops. However, the assessment of the labour market
efficiency revealed that the shadow wages were significantly
deviated from their market levels.

The results of the log-linear multiple regression for the
determinants of labour supply and demand showed that these
forces were affected by factors related to the household
characteristics, economic and non-economic variables. Also
regarding household wages and incomes, the econometric results
showed that they were mostly affected by some variables related to
human and physical capital beside some of the household socio-
economic characteristics.

Based on the farm household model results, the comparison
of the derived shadow wage of labour with their market wage
assured low returns of labour and that the studied farm households
appeared to behave contrary to what is stated in the neoclassical
agricultural household models.

The study recommended some solutions to the problems
related to the agricultural inputs, mainly, labour and ways of their
effective enrollment in farm work and raising their returns levels.
خلاصة الأطروحة

الهدف الأساسي لهذه الدراسة تحليل بعض النواحي الاقتصادية لـ سوق العمالية الزراعية بالتركيز على القطاع المروي ممثلاً في مشروع الجزيرة ومن المؤمل أن يساعد ذلك في الوقوف على بعض المآلات السياسية الصحيحة.

من أدوات التحليل التي استخدمت في هذه الدراسة الإحصاء الوصفي، دالة الإنتاج (Cobb-Douglas)، تحليلات اقتصاد قياسي أخرى مثل التحليل الاقتصادي والبرمجية غير الخطية. كُل هذه طبقت على المعلومات الأولية ذات الصلة بالدراسة التي جمعت من خلال المسح الميداني في مشروع الجزيزة موسم 2003/2004م باستعمال نمذجات الاختيار العشوائي الطبقي متعدد الأطراف لاختيار مائة وخمسون مزارع يمثلون حجم العينة الأولي مع عينة أخرى تمثل العمالية المزروعة بالمشروع (60 عامل).

أوضح نتائج التحليل الوصفي للمزارعين أنهم متجانسون وغالبيتهم تحت الفئة العمرية المنتجة ومتوسط حجم الأسرة يشير إلى وجود حجم عمالية كبير وواضع. كما أن نتائج تحليل العمالية الزراعية أشار إلى أنهم من الفئات العمرية المنتجة في المتوسط وأنهم يتواجدون من مصادر موسمية محلية أو كعمال كتاني.

إضافة إلى ذلك أشار التحليل الوصفي إلى وجود بعض الظواهر ذات الصلة بـ سوق العمالية مثل السراقة وتنوع دخول المزارعين ووجود هجرات داخلية وخارجية وانتشار المجتمع الزراعي بالمشروع.
أظهرت نتائج دوال الإنتاج لمحاصيل القطن والقمح والذرة والفول السوداني بصورة عامة أن عوامل حجم وإنتاج المحاصيل. أيضاً أبرزت نتائج تحليل كفاءة سوق العمالية اختلافاً معنويًا بين سعر الظل للعمال وسعر السوق لها.

نتائج التحليل الارتدادي لمحددات العرض والطلب للعالة الزراعية أوضحت أن هذه القوى تتأثر عموماً بعوامل متعلقة بالصفات الاجتماعية والاقتصادية لأسرة المزارع. إضافة إلى بعض العوامل الاقتصادية وغير الاقتصادية. كذلك أوضحت نتائج التحليل الارتدادي للأجور ومسميات الدخول يتأثرها بعوامل ذات صلة بخصائص الأسرة المزرعية ورأس المال البشري والمادي.

من ناحية أخرى أوضحت نتائج البرمجة غير الخطية أن مقارنة أسعار الظل وأسعار السوق لمصدر العمالية أظهرت تدنى عوائد العمالية مع إظهار أن سوق العمالية يعمل بكفاءة متدنية وليس طبقاً لنظرية المنافسة الكاملة.

من ضمن توصيات الدراسة الإشارة إلى الاهتمام بالمشاكل المتعلقة بالمدخلات الزراعية عوماً والعمالية بصفة خاصة والتركيز على كيفية تشجيعهم لإتقان العمل الزراعي وزيادة عوائدهم منه.
CHAPTER ONE
INTRODUCTION

1.1. Agriculture in Sudan:

Agriculture has been for long time, the backbone of the Sudanese economy and continues to be so for a number of years to come.

Agriculture predominates the Sudanese economy; it is the main source of income for most of the population with a share of 44.5% in the gross domestic product. Table (1.1) presents the contribution of the agricultural sector to the GDP during the period 1990/1991-2001/2004.

The agricultural sector comprises five main sub-sectors: irrigated, mechanized rain-fed, traditional rain-fed, livestock and forestry. Among these sub-sectors, the irrigated sub-sector contributes on average about 27% of the Agricultural Gross Domestic Product. It produces over 95% of Sudan's cotton, most horticultural crops, all the wheat and almost half of the groundnuts. The major public agricultural schemes include; Gezira, Rahad, New Halfa and Suki (Hag El-Amin and El-Maki, 1997). Rain-fed agriculture is the most important activity in the country with about two thirds of the population dependent on it for their livelihood (World Bank Report, 1990).

The irrigated agricultural schemes in Sudan play a significant role in determining the level of output and employment in the economy as a whole. Not only do they produce the country's
major export crop, cotton, they also account for a substantial proportion of the rural labour force, especially seasonal migrant labour (El-Bagir et al, 1984). The irrigated sub-sector consists of irrigated schemes which cover over 4.5 million feddans. This sub-sector is dominated by the Gezira scheme which was the first large scale gravity irrigated project in Sudan. There are now five government owned irrigated schemes: Gezira Scheme (2.1 million feddans), New Halfa (0.4 million feddans), Rahad (0.3 million feddans), and the Blue and White Nile pump Schemes (0.7 million feddans). Historically, these schemes have been viewed as a source of cash crops. Cotton is grown on most of them; sorghum is also grown primarily for on farm consumption. Groundnuts are produced for export and wheat and sugarcane are grown as import substitutes (World Bank Report, 1990).

1.2. The Gezira Scheme:

1.2.1. Background:

The Gezira Scheme is the area that extends from latitude 13 N to latitude 15 N between the Blue and White Niles. The scheme stretches over 115 Kilometres South of Khartoum. It covers a net cultivable area of little less than one million hectares (about 2.1 million feddans) (Adam, 1996).

Estimates of the total potential cultivable area under irrigation in Sudan within the Nile basin vary, but it is probably between four and five million feddans. Hence the Gezira Scheme represents about a quarter of all irrigation area in Sudan and half the area of irrigation schemes drawing water from the Nile system.
It uses about 35% of Sudan's current allocation of Nile water (World Bank Report 2000).

Table 1.1: The contribution of the agricultural sector to the Gross Domestic Products:

<table>
<thead>
<tr>
<th>Season</th>
<th>Percent share to the GDP</th>
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<tbody>
<tr>
<td>1990/91</td>
<td>28.7</td>
</tr>
<tr>
<td>1991/92</td>
<td>33.9</td>
</tr>
<tr>
<td>1992/93</td>
<td>38.1</td>
</tr>
<tr>
<td>1993/94</td>
<td>40.0</td>
</tr>
<tr>
<td>1994/95</td>
<td>43.1</td>
</tr>
<tr>
<td>1995/96</td>
<td>45.0</td>
</tr>
<tr>
<td>1996/97</td>
<td>47.4</td>
</tr>
<tr>
<td>1997/98</td>
<td>47.6</td>
</tr>
<tr>
<td>1998/99</td>
<td>48.7</td>
</tr>
<tr>
<td>1999/2000</td>
<td>49.8</td>
</tr>
<tr>
<td>2000/2001</td>
<td>46.4</td>
</tr>
<tr>
<td>2001/2002</td>
<td>45.6</td>
</tr>
<tr>
<td>2002/2003</td>
<td>46.0</td>
</tr>
<tr>
<td>2003/2004</td>
<td>45.6</td>
</tr>
<tr>
<td>2004/2005</td>
<td>44.5</td>
</tr>
</tbody>
</table>

Source: Bank of Sudan, Annual Reports (various issues).
The irrigation system of the Gezira is basically a gravity flow system where water is derived from Sennar Dam into the two main canals which supply main Gezira and Managil Extension. These canals ramify into laterals and sub-laterals. From these sub-laterals water flows through field outlet pipes into Abu xx and further to Abu v1 (Adam, 1996).

Administratively, the scheme is divided into 18 groups covering the two areas, Gezira and Managil. Each group consists of six to ten Blocks. The scheme is essentially a project which involves three parties; the government, the Sudan Gezira Board and tenants (Adam, 1996).

1.2.2. The economic importance of Gezira Scheme:

The Gezira Scheme, widely known as the Sudan's most successful economic enterprise, is undoubtedly the country’s invaluable asset for generations to come (Yousif, 1997).

Gezira Scheme is the most important component of the agricultural sector in Sudan. According to Adam (1996), its importance to the economic growth can be demonstrated by the following:

- It constitutes about 12% of the total area cultivated in the country and 50% of the area under irrigation.
- It produces 54% and 19% of the country's main export crops, cotton and groundnut, respectively and as such it is a
leading source of foreign exchange earnings and raw materials for local industries.

- It produces 52% and 10% of the country's wheat and sorghum, respectively, as well as considerable amount of vegetables.
- It is a source of labour employment and income for both skilled and unskilled manpower.

Today over 2.7 million people live in and adjacent to the Gezira Scheme and depend on it for their livelihood either as tenants, as agricultural labourers, as sharecroppers, as traders or as providers of various services. The scheme is farmed by about 120000 tenants (World Bank Report 2000).

The Gezira Scheme is not only boosting the national economy at the area of production and labour, but also at other indirect areas such as custom duties on imported machinery, fertilizers, insecticides and all other materials needed for the process of production. It also activates both public and private sectors in areas of transportation, power, telecommunications and commercial banks (Yousif, 1997).

1.2.3. Farming activities:

In the Gezira Scheme, the whole tenancy size ranges between 15 and 40 feddans. The basic unit is “hawasha” which is four feddans in the Gezira main and three feddans in Managil cultivated in rotation.

The present crop rotation is as follows: cotton – sorghum – groundnut – wheat (or other winter crop) – fallow. The crops produced in the Gezira Scheme may be categorized into those,
which are partially financed, by the Sudan Gezira Board and those, which are fully financed by the tenants themselves. The first category includes cotton and wheat and their production is delivered to the Sudan Gezira Board as the main marketing agent. The second category includes sorghum, groundnut, vegetables and legumes and the tenants themselves are the main disposers (Gezira Scheme Rehabilitation Report 1994).

1.2.4. Input levels and costs:

Gezira Scheme is essentially a project which involves three parties: the central government provides finance and buys the cotton and wheat harvests at predetermined producer prices; Sudan Gezira Board manages operations; and tenants provide the required agricultural labour. These respective roles dictate the types of costs, which are accounted for. Sudan Gezira Board costs can be classified into administrative costs and production costs. The administrative costs are those which do not directly relate to agricultural operations, whereas, production costs are those which directly relate to agricultural operations (World Bank Report, 1990). Table (1.2) presents current input levels used for different crops per feddan.

The Sudan Gezira Board organizes the supply of the main material inputs through finance from the Consortium. Credit is furnished both in kind and in cash. Credit in kind is mainly in form of agricultural inputs, e.g. seeds, fertilizers, pesticides and machinery (Adam, 1996). Production costs in Gezira scheme for the major field crops can be categorized into land preparation, cultural operations, material inputs, harvesting operations and
other cost items such as the cost of transportation, Zakat, taxes and services. Depending on the crop, each cost category consists of many cost items (World Bank Report, 1990).

According to Adam (1996), the present production relation system is based on the individual account system where each tenant has his own cost of production and that of land and water charges. This system has been introduced in the Gezira Scheme in the season 1981/82 to replace the joint costs account system which was a form of joint profit sharing between tenants, government and the Sudan Gezira Board.

1.2.5. Output marketing and pricing:

Governments in many developing countries frequently interfere in agricultural markets, particularly output markets. The Sudanese government is not an exception. The agricultural pricing in Sudan was determined by direct and indirect interventions. The prime motivations of these interventions were protection of consumers and realization of revenues to government (Adam, 1996). The prices received by the farmer and his yield levels are the most important factors determining farm incomes, credit requirements and ability to pay debt (World Bank Report, 1990).

With regard to export crops, cotton and groundnut, the marketing operations of cotton is exclusively controlled by the public sector while groundnut marketing is characterized by partial intervention of the public agencies. Sorghum marketing is characterized by periodic intervention of the public agencies primarily through price support. Wheat marketing is characterized
by partial intervention of public agencies, mainly in relation to imports (Adam, 1996).

1.3. The agricultural labour in Sudan:

In a broad sense, labour market encompasses three functions. These are the processes whereby labour supply and demand are matched, wages and salaries determined, and labour allocated between occupations and sectors (Fallon, 1994).

The population of Sudan, like that of most other developing countries is predominantly rural. In Sudan, many of the productive activities are organized not on market principles, but on a more informal flexible set of arrangements which allow for self employment as well as forms of non-market labour trading within and between households (El-Bagir et al, 1984).

Given the inherited dual structure of the economy, it is perhaps not surprising that a dual labour market has continued to exist over the period since independence; a fairly large market in the rural traditional sector and a small, but growing urban modern market. The rural labour market is perceived to be largely competitive, or flexible, with self employment as the dominant form of employment. The urban labour market has started as a protected market, but has experienced increasing flexibility since the late 1970’s (Ali and Elbadawi, 2002).

Historically, the development of the agricultural labour force in Sudan since the British conquest, according to O'Brien (1983) has passed through four distinct phases. These phases have each been characterized by distinct policies towards labour and agriculture and by different patterns of expansion of both
agriculture and agricultural labour market. In phase one, 1898 – 1925, the agricultural development was limited to small scale experimentation with cotton cultivation and was rigorously supervised by the government. In phase two, 1925 – 1950, the desire to secure supply of seasonal labour to the Gezira scheme and a few pump irrigated private cotton estates established later, dominated all labour policy. The settlement of large numbers of West Africans Muslim immigrants in and around the Gezira area to act as a labour supply was encouraged by the British. In phase three, 1950 – 1975, the nationalization of Gezira scheme occurred and a rapid expansion of capitalist agriculture began. The corresponding expansion in the demand for seasonal labour force was met through an elaborate system of recruitment and resulted in the formation of a labour force that was highly segmented into distinct markets for different agricultural tasks e.g. cotton picking, dura harvesting, .etc. In phase four, 1975 – to the present, the deepening economic crisis, accompanied by the accelerating inflation which began in 1973 started to have noticeable effects on the agricultural labour markets by 1975 as wage rates began to rise sharply. The recruitment system and the barriers between segments of the labour market began to breakdown leading to the formation of a national labour market.

Wage employment in rural areas occurs in two main sectors; in the large state-owned and managed irrigated schemes and in the large mechanized farms. Labour is supplied to these sectors from several sources; local small-scale farmers who supplement their incomes by seasonal wage employment, local landless labourers
who may work both in agricultural and non-agricultural activities, temporary migrants and nomads (Fallon, 1994).

According to the 1993 census, the total population of Sudan was estimated as 2490683 persons, out of which about 6285052 persons were living in urban areas (25.2%), 16535672 persons were living in rural areas (66.3%) and about 2119958 persons were considered as nomads (8.5%). The total labour force was estimated as 8927000 persons, of which about 5044000 persons represented the agricultural labour force (57%). Table (1.2) presents the total population, total labour force and the agricultural labour force in the period 1990 – 2000 in Sudan. Table (1.3) shows an expected development of Sudan's labour force during the period 1975 – 2000. Table (1.4) shows the total labour force and unemployment rates in 1973, 1983 and 1993 censuses.
Table 1.2: The total population, total labour force and the agricultural labour force during the Period 1990 – 2000 in Sudan (1000 persons):

<table>
<thead>
<tr>
<th>Year</th>
<th>Total population</th>
<th>Rural population</th>
<th>% rural to total pop.</th>
<th>Total lab. force</th>
<th>Agric. lab. Force</th>
<th>% agric. to total lab. force</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>24950.0</td>
<td>15034.0</td>
<td>60.3</td>
<td>8172.0</td>
<td>4923.0</td>
<td>60.2</td>
</tr>
<tr>
<td>1991</td>
<td>25648.0</td>
<td>15885.5</td>
<td>61.9</td>
<td>8417.0</td>
<td>4970.0</td>
<td>59.0</td>
</tr>
<tr>
<td>1992</td>
<td>29186.0</td>
<td>16458.59</td>
<td>62.9</td>
<td>8675.0</td>
<td>5018.0</td>
<td>57.8</td>
</tr>
<tr>
<td>1993</td>
<td>24940.68</td>
<td>16485.6</td>
<td>66.1</td>
<td>8927.0</td>
<td>5044.0</td>
<td>56.5</td>
</tr>
<tr>
<td>1994</td>
<td>25596.62</td>
<td>16891.45</td>
<td>65.9</td>
<td>5964.0</td>
<td>4587.0</td>
<td>76.9</td>
</tr>
<tr>
<td>1995</td>
<td>26264.69</td>
<td>17332.32</td>
<td>66.0</td>
<td>6119.67</td>
<td>4738.0</td>
<td>77.4</td>
</tr>
<tr>
<td>1996</td>
<td>27158.19</td>
<td>17652.82</td>
<td>65.0</td>
<td>6327.86</td>
<td>4899.2</td>
<td>77.4</td>
</tr>
<tr>
<td>1997</td>
<td>28465.93</td>
<td>18594.06</td>
<td>65.3</td>
<td>6632.56</td>
<td>4915.9</td>
<td>74.1</td>
</tr>
<tr>
<td>1998</td>
<td>29496.12</td>
<td>19031.93</td>
<td>64.5</td>
<td>8375.0</td>
<td>6113.0</td>
<td>73.0</td>
</tr>
<tr>
<td>1999</td>
<td>30326.0</td>
<td>20250.20</td>
<td>66.8</td>
<td>8700.0</td>
<td>6264.0</td>
<td>72.0</td>
</tr>
<tr>
<td>2000</td>
<td>31081.0</td>
<td>20731.0</td>
<td>66.7</td>
<td>9037.61</td>
<td>6418.73</td>
<td>71.0</td>
</tr>
</tbody>
</table>

Table 1.3: Sudan’s labour force, 1975 to 2000 (in thousands)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>2916.0</td>
<td>3215.9</td>
<td>34814.6</td>
<td>3758.6</td>
<td>4037.1</td>
<td>4320.0</td>
</tr>
<tr>
<td>Female</td>
<td>881.1</td>
<td>976.5</td>
<td>1063.7</td>
<td>1154.6</td>
<td>1241.0</td>
<td>1346.8</td>
</tr>
<tr>
<td>Both sexes</td>
<td>3797.1</td>
<td>4192.4</td>
<td>4648.3</td>
<td>4913.2</td>
<td>5286.1</td>
<td>5266.8</td>
</tr>
<tr>
<td>Rural (%)</td>
<td>81</td>
<td>76</td>
<td>73</td>
<td>67</td>
<td>63</td>
<td>59</td>
</tr>
<tr>
<td>Urban</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>830.8</td>
<td>1178.0</td>
<td>1619.7</td>
<td>2176.6</td>
<td>2849.0</td>
<td>3623.9</td>
</tr>
<tr>
<td>Female</td>
<td>86.5</td>
<td>122.9</td>
<td>168.9</td>
<td>227.2</td>
<td>297.4</td>
<td>378.3</td>
</tr>
<tr>
<td>Both sexes</td>
<td>917.3</td>
<td>1300.9</td>
<td>1788.6</td>
<td>2404.8</td>
<td>2146.4</td>
<td>4002.2</td>
</tr>
<tr>
<td>Urban (%)</td>
<td>19</td>
<td>24</td>
<td>27</td>
<td>33</td>
<td>37</td>
<td>41</td>
</tr>
<tr>
<td>Sudan</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>3746.8</td>
<td>4394.7</td>
<td>5103.8</td>
<td>5935.2</td>
<td>6886.1</td>
<td>7943.9</td>
</tr>
<tr>
<td>Female</td>
<td>967.6</td>
<td>1009.4</td>
<td>1232.6</td>
<td>1381.8</td>
<td>1546.4</td>
<td>1725.1</td>
</tr>
<tr>
<td>Both sexes</td>
<td>4714.4</td>
<td>5494.1</td>
<td>6336.4</td>
<td>7317.0</td>
<td>8432.5</td>
<td>9669.0</td>
</tr>
</tbody>
</table>


Table 1.4: Total labour force and unemployment rates in Sudan in 1973, 1983 and 1993 Censuses:

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Labour Force</th>
<th>Unemployment rates (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1973</td>
<td>3679878</td>
<td>5.5</td>
</tr>
<tr>
<td>1983</td>
<td>6344000</td>
<td>8.3</td>
</tr>
<tr>
<td>1993</td>
<td>8927000</td>
<td>11.1</td>
</tr>
</tbody>
</table>

1.4. The agricultural labour in Gezira Scheme:

The essence of Gezira Scheme is that, the tenant, along with family and additional hired labour for weeding and harvesting, is expected to manage and farm the holding alone (Fallon, 1994). With the historical development of the scheme in its early stages, the magnitude of labour supplied from within the scheme was not sufficient to combat requirements and bottlenecks. Nevertheless, the flow of labour from the labour surplus areas of the West, from other parts of Sudan and even from outside the Sudan, made it possible to secure sufficient labour for agricultural work in the scheme (El-Jack, 1986). However, the World Bank Report (2000) mentioned that, studies conducted by the socio-economic Unit of Gezira Board found that, with increasing farmer wealth, educational achievements and social aspirations, less than 20% of tenants rely on family labour in agriculture and that hired labour is a dominant factor of production. Most of the contribution of family labour is in watering of cotton and wheat. However, labourers who are sharecroppers in sorghum, groundnut and vegetables are responsible for almost all the operations in agriculture.

Farm labour in Gezira Scheme can be classified into family and hired labourers. Family labourers include the unpaid members of the tenant’ household, including the tenant himself, his wife(s), sons and daughters or any person who shares a common livelihood with the tenant. The hired labourers can be further divided into regular and casual hired labourers. The regular hired labourers may work on the farm throughout the year, while the casual hired labourer is the one who has a periodic mobility and utilization in a certain area away from his home area (El-Shafei, 1992 cited in
Babikir, 1998). According to its source, labour in Gezira Scheme can be divided into family, local and migrant labour. Local labour includes all labourers whose permanent homes are within the scheme area, some of them migrated to the scheme some years ago and they provide a permanent source of casual labour. Migrant labour includes all labourers who are hired during the season and whose permanent homes are outside the scheme area (El-Amin, 1981). However, El-Jack 1986) classified the labour sources into, the tenant and his household, labour from Gezira villages, labour from the permanent labour camps and seasonal migrants from outside the Gezira state. Table (1.6) presents the manpower in the Gezira scheme.

With the economic crisis of 1931, many tenants abandoned the scheme due to financial difficulties and the scheme administration thus allowed non-Sudanese to become life-tenants. This led to an increase in migration from Western Sudan (Kordofan and Darfur) as well as large numbers from West Africa. A number of these migrants initially held tenancies, while many more came for seasonal labour on route to or from the pilgrimage in Mecca (World Bank Report, 2000). It was estimated that, 16% of the total population of the Gezira was made up of labour migrants. Also it was estimated that 33% of the labour camps are along the canals, 30% inside tenancies, 19% near villages and 18% in other places (Gezira Rehabilitation Project Report, 1994). Table (1.7) shows the ethnic composition of the population in the Gezira State.

In the interview with tenant farmers and administration officials by the researcher, it was expressed that the migrant
population was considered to constitute a problem to the scheme. The different ethnic groups and the associated different cultures have made assimilation difficult. Available literature and studies by the Socio-economic Unit of Gezira Board show that, the scheme saw in-migration of labourers up to the 1989/90 season. Since then, there has been a decline in the number of migrants seeking work in the scheme. Seasonal labourers have also been affected by the poor performance of the scheme. Wages become less attractive in the scheme compared with those in other agricultural schemes. The Gezira Board stopped recruitment campaigns because of the high cost. In view of the poor performance, many tenants are no longer able to pay the labourers on time because of lack of money (World Bank Report, 2000).

Table 1.6: Man power in the Gezira Scheme:

<table>
<thead>
<tr>
<th>Item</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tenants</td>
<td>116000</td>
</tr>
<tr>
<td>Officials</td>
<td>2805</td>
</tr>
<tr>
<td>Permanent labour</td>
<td>10085</td>
</tr>
<tr>
<td>Causal labour</td>
<td>10500</td>
</tr>
<tr>
<td>Seasonal labour</td>
<td>50000</td>
</tr>
<tr>
<td>Local labour</td>
<td>70000</td>
</tr>
<tr>
<td>Seasonal ginning labour</td>
<td>13500</td>
</tr>
</tbody>
</table>

Table 1.7: The ethnic composition of the population in Gezira State:

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Ethnic group</th>
</tr>
</thead>
<tbody>
<tr>
<td>2715605</td>
<td>Total</td>
</tr>
<tr>
<td>83.3</td>
<td>Arab groups:</td>
</tr>
<tr>
<td>3.0</td>
<td>Baggara</td>
</tr>
<tr>
<td>1.5</td>
<td>Dar Hamid</td>
</tr>
<tr>
<td>0.4</td>
<td>Bederiya</td>
</tr>
<tr>
<td>17.9</td>
<td>Gaaliyin</td>
</tr>
<tr>
<td>12.2</td>
<td>Guheina</td>
</tr>
<tr>
<td>48.3</td>
<td>Other Arab groups of Central Sudan</td>
</tr>
<tr>
<td>1.0</td>
<td>Beja</td>
</tr>
<tr>
<td>2.2</td>
<td>Nuba</td>
</tr>
<tr>
<td>2.3</td>
<td>Nubians</td>
</tr>
<tr>
<td>5.9</td>
<td>West Darfur</td>
</tr>
<tr>
<td>0.9</td>
<td>S. Sudanese</td>
</tr>
<tr>
<td>2.9</td>
<td>Nigerians</td>
</tr>
<tr>
<td>0.8</td>
<td>Other non-Sudanese</td>
</tr>
<tr>
<td>0.6</td>
<td>Tribe not stated</td>
</tr>
</tbody>
</table>

CHAPTER TWO
RESEARCH METHODOLOGY

This chapter presents the problem statement, objectives of the study, hypotheses to be tested and the analytical techniques used to test these hypotheses. It also covers the data sources, sample design, sample size and the organization of the study.

2.1. Problem statement:

The development of neoclassical labour economics has been the result of a gradual realization of the fact that real world labour market characteristics are inconsistent with the perfectly competitive model (Adnett, 1989).

It has long been recognized that, the need for special theory of the labour market arises because of the peculiar properties of labour, which distinguish it from other commodities (Sapsford and Tzannatos, 1990). In practice, unique market clearing prices are rare. This is true for markets in general, but is probably particularly true for labour markets (Polachek and Stanley, 1993).

The labour market conditions prevailing in the rural areas of developing countries have been observed to resemble those of a typical neoclassical economy, leaving the workers at the mercy of market forces to fight for their needs (Sharif, 2000). Monopolistic conditions occur often in developing countries labour markets, and can be a result of concentrated ownership of land, credit and product monopolies, sharecropping arrangements, restrictions on labour mobility or lack of alternative employment possibilities (Grootaert and Kanbur, 1995).
Teal (1995) identified two contrast views of the labour market in the developing countries, one is competitive and the other is non-competitive. Also in the context of Africa, Adenikinju and Oyeranti (2000) mentioned that, there are two competing views on how the African labour markets function, one view is competitive, and another is non-competitive. The two views found empirical support.

In the context of Sudan, Kevane (1994) argued that, the evidence from Sheikan district in Western Sudan support that, labour markets are well established, capitalistic and competitive. Supply and demand affect wage rates and patterns of employment. In his study of labour supply in Gezira Scheme, El-Jack (1986) concluded that, the rural labour market in Gezira is competitive and it functions according to the forces of supply and demand.

A complete analysis of labour market behaviour required an explanation of the determinants of demand, supply and wage rates (Papola and Misra, 1980). Given the evidence on high rates of labour market participation, high rates of open unemployment and high rates of geographical and occupational mobility, the presumption should be that rural labour markets are subject to the forces of supply and demand in either a competitive, dualistic or monopsonistic setting. The presumption, if substantiated however, does indicate that a solution to the problems of low returns to labour is not found in the operation of the labour market. Instead, it is to be sought in the distribution of land ownership, in the operation of capital markets, in the pricing policy for agricultural output or in population or education policy. In other words, attention should be directed to the factors determining labour
demand and supply, rather than to the operation of the labour market itself (Squire, 1981). Research cannot be satisfied with concluding that labour markets are widespread and competitive. It must ask how they are competitive and how they coexist with non-market institutions (Kevane, 1994).

One common and recurring finding in rural areas of low-income developing countries is the absence of well functioning markets, especially for labour but often for other inputs and output as well. Markets have been said to fail or to be inefficient when the factor or product prices fail to equilibrate supply and demand (Lamb and Worthington, 2003). Thus, given the importance of labour as a major factor of production in agriculture, the relative neglect of the economics of the labour markets in Sudan and the prevailing rigidities in them, this study seeks to contribute to the on-going debates about labour markets characterization in Sudan, with the Gezira Scheme cited as a model for the irrigated agriculture.

2.2 Objectives of the study:

The main objective of this study is to analyze some economic aspects of the agricultural labour market in irrigated agriculture with reference to Gezira Scheme, which may help in drawing some soundly based policy implications. The specific objectives are:

1. To estimate the labour requirements per feddan for the major field crops in Gezira Scheme and to specify the possible determinants of labour demand functions.
2. To estimate the available supply of labour during the season and to specify the possible determinants of labour supply functions.

3. To study the process of wage determination and determinants of incomes in Gezira Scheme.

4. To shed some light on other aspects related to labour market performance such as migration and sharecropping practices.

5. Draw conclusions and implications for policy and future research.

2.3 Hypotheses of the study:

Based on the reviewed literature, the following hypotheses are expected to hold:

1. The rural labour market in Gezira Scheme is expected to work efficiently and as predicted by the neoclassical competitive theory.

2. It is expected that a negative and significant relationship exists between the total amount of labour demanded by the major field crops in Gezira Scheme and wage rates.

3. None of the demographic variables have a significant effect on the total labour demanded for the major field crops in Gezira Scheme.

4. There is a positive and significant effect of capital expenses on total labour demand for the major field crops in Gezira Scheme.

5. The relationship between the total amount of work supplied to agricultural production of the major field crops in Gezira
Scheme and the real wage rate is expected to be positive and significant.

6. There is a negative relationship between total supply of labour to agricultural production of the major field crops in Gezira Scheme and the total tenant income.

7. There would be a positive relationship between the number of male or female per household and their labour supply for agricultural production of the major field crops in Gezira Scheme.

8. The average total cultivated land is expected to have a positive and significant effect on average wage rates in Gezira Scheme.

2.4. Analytical techniques:

The analytical techniques involve the following:

1. Descriptive statistical analysis
2. Production function approach
3. Regression analysis

Descriptive analysis is used to analyze the following:

• The demographic composition and household structure of the Gezira tenants.
• Labour requirements of the major field crops in Gezira Scheme.
• Labour requirements of the major field crops by operation.
• Gender and sex allocation of labour.
• Input levels for the major field crops in Gezira Scheme.
• Some socio-economic characteristics of landless agricultural labourers in Gezira Scheme.
• Wage structure and rates in Gezira Scheme.

The estimation of the production functions may help in:
• Analyzing the output response to labour input, human capital and farm production characteristics.
• Testing for the efficiency of the labour market and assessing the shadow wages of labour.

Regression methods are used in the specification of the determinants of labour supply and demand, as well as of wage rates in Gezira Scheme. By the non-linear programming a simple farm household model will be solved.

2.5 Data sources:

In this study, the used data were from two sources; primary and secondary.

2.5.1. Primary data:

Primary data were collected from the tenant farmers and agricultural labourers through personal interviewing using a structured questionnaire. Panel data concerning information about labour in Gezira Scheme were collected during season 2003/2004, in three different surveys:

• July-September: the first survey in which data on presowing and sowing operations were collected concerning the four major field crops in the scheme.
October–January: the second survey, where data on weeding and harvesting of dura and groundnut were collected.

February-May: the third survey, where data on harvesting of cotton and wheat and post-harvest operations were collected.

The collected data from the tenants include information on the tenant’s socio-economic characteristics, areas, production, labour sources and labour allocation with respect to sex and operation. It also include information on labour requirements and supply during the season for each crop, cost values, output prices, number of days absent, distance from town and village, previous and present tenants incomes and gross values of outputs. The collected data from agricultural labourers include information on the socio-economic characteristics of the labourers, the wage rates and the operations for which they are hired.

2.5.2. Secondary data:

The secondary data include information about the total population, total labour force and the total agricultural labour force in Sudan. Sources of these data were the Ministry of Manpower and Administrative Reform, Arab Organization for Agricultural Development and the Sudan Gezira Board.

2.6. Sample design:

Increase in the selection process of a simple random sampling could be achieved by either increasing sample size or by stratification of the population into more homogeneous groups.
using knowledge of the population characteristics to increase precision and representativeness of sample (Hansen, et al, 1970).

Since the Gezira Scheme is divided into groups, which are further sub-divided into Blocks, covering the two areas, Gezira main and Managil Extension, a random multi-stage sampling was used for the collection of the primary data. Randomly three groups and two groups were selected from Gezira Main and Managil Extension respectively. Then two Blocks were randomly selected from each group (10 Blocks) and from each Block 15 tenants were randomly selected.

The selected groups were namely: the Central, Masalamyia and Northern groups from Gezira Main, Matoug and Mekashfi groups from Managil Extension. The chosen Blocks were: Barakat and Abdel Hakam (Central group), Tayba and Abdel Galil (Masalamyia group), El Sahwa and Alti (Northern group), Matouri and El-Nour (Matoug group), Murad and El-Kiraimit (Mekashfi group).

2.7. Sample size:

Assuming that the population of the Gezira Scheme is relatively homogeneous (Adam, 1996) and considering the limitations of funds and time, a sample size of 150 tenants and 60 labourers was justifiable to represent this population.

2.8 Thesis organization:

This study is divided into eight chapters; chapter one gives a brief summary about agriculture in Sudan, the Gezira Scheme and its importance to the Sudanese economy and agricultural labour in Sudan and in Gezira Scheme. Chapter two defines the research
problem, states the objectives, describes the research methodology and indicates the sources of data.

Chapter three is concerned with literature review. In this chapter, the labour markets in general and agricultural labour markets in particular, wage theories and labour supply and demand were reviewed.

Chapter four presents and discusses the descriptive analysis of the study. Chapter five presents and discusses the econometric results concerning the production function analysis, the results of the determinants of labour demand, supply, wages and incomes in Gezira Scheme. Chapter six presents and discusses results pertaining to the farm household model.

Finally chapter seven provides a summary, conclusions and recommendations.
CHAPTER THREE
LITERATURE REVIEW

This chapter is intended to review literature on agricultural labour markets, the non-farm labour markets, migration, theory of wages, and demand and supply sides of the agricultural labour markets.

3.1 Labour markets: An overview:

Factor markets are the markets for factors of production such as labour, capital and land. However attention often focuses on labour and capital. Perhaps, this is because land is regarded as a free gift of nature, with relatively inelastic supply (Adenikinju and Oyeranti, 2000)

Labour in economics means any sort of human effort exerted in production (Reynolds, 1982). Labour market is defined as the market that allocates workers to jobs and coordinates employment decisions (Ehrenberg and Smith, 1985). It has long been recognized that, the need for special theory of the labour market arises because of the peculiar properties of labour, which distinguish it from other commodities (Sapsford and Tzannatos, 1990). Reynolds, (1982) list the following features that differentiate labour markets from commodity markets:-

- Multiplicity of markets.
- No central or single point of sale.
- Workers not standardized.
- Continuity of employment relation.
- A worker delivers himself along with his labour.
- Workers inferiority in bargaining power.
3.2. Labour markets in developing countries:

Labour is by far the most abundant resource in low-income countries (Rosenzweig, 1988). Hiring-out their labour has increasingly become a source of livelihood for a large number of workers in the rural areas of developing countries (Radwan, 1989). The determination of the returns to labour plays a central role in models of development (Rosenzweig, 1988).

There is an ongoing debate in development economics as to the appropriate characterization of rural labour markets. The debate centred around the issue of whether these labour markets can be described by a competitive supply and demand system, or whether there are sufficient rigidities to make a neoclassical model misleading (Benjamin, 1989). One polar view of labour markets in developing countries was that such markets are riddled with imperfections and/or operate quite distinctly from those in high-income countries. The alternative view was that labour markets in low-income countries conform more closely to Marshalian markets that do such markets in high-income countries (Rosenzweig, 1988, Benjamin, 1992, Kevane, 1994, and Teal, 1997). There now appears to be important elements of truth in both views (Rosenzweig, 1988).

Rosenzweig, (1988) mentioned that the features of low-income countries that require attention in modeling the operation of labour markets are:

- The large proportion of the labour force in agriculture.
- Low proportion of workers who earn income wholly or chiefly in the wage labour market compared to the labour force in high-income countries.
The behaviour of the family enterprise and its members, particularly in the context of agricultural production, thus form the core of many labour market models depicting low-income labour markets.

However, Benjamin (1989) in his analysis of rice rural labour markets in Java concluded that there is evidence that with respect to rural rice labour markets in Java, one does no obvious wrong in modeling them within a neoclassical supply and demand framework.

In the Asian context, market failure has been attributed to price and yield uncertainty coupled with risk aversion. In a deterministic setting, the failure of labour markets to clear may be due to differing efficiencies of household and to the requirement to supervise hired labour (Lamb and Worthington, 2003). However, Binswanger and Rosenzweig (1984) argued that, competitive market outcomes could result in extremely low wages and/or in adverse contractual terms if labour supply is large relative to demand. Thus even extremely low wage levels do not necessarily indicate either market failure or the prevalence of monopolistic or monopsonistic exploitation. However, Stiglitz, (1988) argued that, in many less developing countries, there is a well-developed labour market. Many landlords need labourers at harvest time and at planting time. The worker has a choice of for whom he can work. The fact that wages in some location appear low relative to other locations is not necessarily evidence of exploitation; the competitive market will yield low wages when the value of the marginal product of labour is low. Rosenzweig, (1980) using Indian data, established a test of the competitive framework and
concluded that, empirical results were generally supportive of the neoclassical framework. Hart and Sisler, (1978) in their analysis of Javanese rural labour markets, reported that, the question of whether or not labour markets function along neoclassical lines must be defined from the viewpoint of the individual household. From this perspective, there are two critically important implications inherent in the perfect labour market assumption. First, the wage rate is independent of hours worked. Second, all people with given skills and physical capabilities have equal access to labour markets. Then their results showed that, the relationship between wage rates and hours worked reveals that labour markets operate with a substantial degree of sensitivity to seasonal variations in demand and work opportunities.

In support of the second view, Radwan (1989) concludes that, theories attempting to model the rural economies of developing countries have exhibited a notable divorce from reality. For instance, the competitive model, which seeks to explain labour returns in terms of smoothly functioning labour markets, has now been widely rejected. Most of these analyses explain labour transactions in terms of market functioning, but the role of non-market and extra-economic factors can be crucial in determining labour incomes. Different non-market institutions coexist with markets even in the most advanced economies. The importance of the institutions such as firms, families, contracts, market rules and regulations and social norms to economic development was realized in the writings of many economists (Bardhan 1984; Lin, 1995; Basu, 2003). Teal, (1997) using data from Ghana, found that the labour markets do clear, although they were not competitive.
Using simultaneous equation model of cultivator households from India, Kanwar (1998) concludes that, given non-clearing rural labour markets in developing agriculture, we are able to test the hypothesis that the casual labour market does not clear.

3.3 Labour markets imperfections:

One common and recurring finding in rural areas of low-income developing countries is the absence of well functioning markets, especially for labour but often for other inputs and output as well. Markets have been said to fail or to be inefficient when the factor or product prices fail to equilibrate supply and demand. Thus labour market failure is characterized by wages that fail to clear the labour market (Lamb and Worthington, 2003). Absence of well-functioning markets in developing countries, mean that factor services (e.g. labour, capital, etc.) as well as goods demanded in the various markets (e.g. capital goods) are either lacking or available in insufficient quantities, or that goods and services are largely allocated through non-market channels. In such a situation, neoclassical strategies that assume existence of a perfectly functioning market mechanism were rejected in less developing countries (Dike, 2003). Imperfections in labour markets are a common feature of backward agricultural economies. Extremely unequal distribution of land, massive unemployment or underemployment, low geographical mobility due to high travel or migration costs, and lack of alternative employment opportunities faced by the village workers give rise to monopsonistic or oligopsonistic power in the hands of a few large farmers (Bardhan, 1984; Binswanger and Rosenzweig, 1984). In
place of the free market strategies, a mixed economy approach was posited involving a complementary package of market mechanisms and state interventions to take care of the pervasive market failures arising from weak institutions and malfunctioning markets associated with underdevelopment (Stiglitz, 1989). Generally, Stiglitz (1988) mentioned the following market failures relevant to the less developing countries:

- Widespread urban unemployment within these countries suggesting that wages are set at levels above market clearing.
- Large wage differentials for labourers of seemingly equivalent skill levels.
- Extensive migration from the rural to the urban sector, in spite of the high level of unemployment.
- The use of sharecropping within the rural sector.
- In economies which make use of sharecropping, interlinkages of credit and land markets and sometimes of other markets, the landlord is frequently also the supplier of credit. These market failures could be explained by imperfect information or by using the transaction costs approach.

Given the evidence on high rates of labour market participation, low rates of open unemployment and high rates of geographical and occupational mobility, the presumption should be that rural labour markets are subject to the forces of supply and demand in either a competitive, dualistic or monopsonistic setting. The presumption, if substantiated, however, does indicate that a solution to the problem of low returns to labour is not to be found in the operation of the labour market. Instead, it is to be sought in
the distribution of land ownership, in the operation of capital markets, in the pricing policy for agricultural output or in population or education policy. In other words, attention should be directed to the factors of determining labour demand and supply, rather than to the operation of the labour market itself (Squire, 1981). Labour markets in general tend to have a slower adjustment mechanism than other markets. The imperfections and rigidities are however found to a much greater degree in the labour market. Practices of sharecropping, co-operative group work between farmers and the peculiar nature of unemployment among agricultural workers are examples of such rigidities (Papola and Misra, 1980).

Analyzing the rural labour markets in developing countries, Jazairy, et al (1992) summarized the characteristics of these markets in the following points:

- Seasonal fluctuations in labour demand.
- Large scale migration across national borders.
- Intra-rural migration.
- Integration of rural and urban labour markets.
- Interlocking factor markets.

Tackling seasonality, White and Leavy (2000) reported that, agricultural production is seasonal, with very dramatic variations in labour requirements during the year. The peaking of labour demand is made all the more urgent by the link between timely planting, harvesting, storage and productivity. They also added that, seasonality is a critical factor, which cannot be ignored in modeling household labour decisions. It also meant that, there is
likely to be migration. Empirically, Jarvis and Toscano (2004) offered evidence from Chile, stating that, it has been observed that the adjustment process in the agricultural casual labour markets is often uneven and incomplete resulting in a significant degree of unemployment because of the seasonality of agricultural demand. Kanwar, (2004) using Indian data, found that while the agricultural labour market appears to be in equilibrium during the rainy season, it manifests excess supply in the post-rainy season. However, Bardhan (1979) claimed that, agricultural wages are rigid in the face of significant seasonal fluctuations in labour demand and that seasonal adjustment occurs through variations in the rate of unemployment. Skoufias (1993) with data from India, modeled seasonality in agriculture as a dynamic two stage process (planting and harvesting). He concluded that, the response of rural labour wages and employment to shifts in the demand for or supply of labour differs substantially from season to season. Nevertheless, Datt and Olmstead (1998) in their study of agricultural wages in Egypt concluded that, conditional on all the other determinants of agricultural wages, we found no evidence of seasonal effects.

Facing unequal market power and variable prices for outputs and inputs, peasants may choose to preserve a non-market basis for survival. In doing so, the corresponding good or factor becomes non-tradable, which gives rise to interlinked or interlocked markets (Zaibet and Dunn, 1998). Defining the term interlocking markets, Leavy and White (2003) stated that, it is a situation where terms of exchange in one market are contractually tied to those in other markets. They further argued that, the neoclassical interpretation of interlocking markets is that they are
means by which profit-maximizing landowners overcome the inefficiencies of incomplete markets and reduce associated transaction costs. An interlinked transaction is one in which the parties trade in at least two markets, on the condition that Transaction costs include high transport cost, high marketing margins and high costs of searching and monitoring contracts. They also result from information inefficiencies and institutional problems, such as the absence of formal factor markets (Zaibet and Dunn, 1998). Bardhan (1984) mentioned two prominent causes of interlinkage in rural markets, the potential risk and the moral hazard problem, in which interlinkage emerges as a device for monitoring work effort. The most commonly discussed arrangement in interlocked markets is the sharecropping contract. It combines markets for labour, land, credit, and insurance (Zaibet and Dunn, 1998).

For many years, the crucial distinguishing feature of a less developed country was taken to be its dualism in which two sectors were identified, the modern and the traditional one (Basu, 2003). Labour market dualism, resulting from institutional barriers to entry into the formal or protected sector has long been considered the distinctive feature of labour markets in developing countries (Assaad, 1997). Scholars who have studied the actual performance of markets in the African continent know that institutional arrangements and transaction costs shape the patterns of trade and partly determine the extent to which allocative efficiency is achieved( Fafchamps, 1997). Economists who are dissatisfied with Orthodox theory have proposed different explanations of how labour markets operate. They reject a
predominant competitive analysis, insisting instead upon the fragmented nature of labour markets and the importance of institutional and social influences upon pay and employment. Labour market segmentation provides a common label for these alternative approaches (Mc Nabb and Ryan, 1990; Basch and Molina, 1996; Bardhan and Udry, 1999; Basu, 2003). In reality, labour markets are often segmented, with different wages prevailing in different markets; for instance, agricultural wages may be lower than wages in the manufacturing sector (Basu, et al, 1998; Basu, 2003). Gindling, 1990) defines labour market segmentation as a situation where, because of institutional barriers to occupational mobility between sectors, a worker in a lower sector has less than full access to a job in the upper sector held by an observationally identical worker. Then he argued, if there were no barriers, workers in the low wage sector would enter the high wage sector and force the wages down until wages across sectors were equalized. Then he formulated a test of this dualism in Costa Reca; his finding is an evidence of labour market segmentation. Molina and Basch (1996) have presented strong evidence that the labour market in Chile can best be characterized by two labour markets instead of one. Assaad (1997), using data from a survey of construction workers in Egypt, found that rationing of entry into craft occupations exists according to a worker’s regional background, whereas the kinship ties and social networks indirectly contribute to rationing. However, Basu (2003) mentioned that, while developed countries may have traits of dualism, the claim behind the dual economy literature is that such dualism is much sharper in less developing countries.
One of the more frequently cited empirical observations on rural production patterns in less developed countries is the systematic relation between farm size and land productivity (Feder, 1985; Benjamin, 1989, 1992; Kevane, 1996; Dorward, 1999; Lamb, 2003; Juliano and Ghatak, 2003; Basu, 2003). Because of its wide-reaching implications, the inverse relationship between farm size and output is one of the most important and hotly discussed stylized facts of rural development (Heltberg, 1998).

Generally, a dual economy consists of two sectors; the industrialized (urban) and the agricultural (traditional) sectors. The labour market in the dual economy is, or at least appears to be stratified into two parts, with the workers in the industrial sector earning higher wages than their counterparts in the rural sector (Basu, 2003). The literature on the inverse relationship between farm size and yield was developed in the context of India, and relied primarily on imperfections in land and labour markets (Kevane, 1996). The presence of a dual labour market where smaller farms face cheaper labour cost implies higher labour/land ratios on smaller farms and therefore higher per are yields (Feder, 1985; Kevane, 1996; Basu, 2003). Unless labour and other markets work perfectly, the resulting allocation of land and labour will be inefficient. The conventional explanation of the inverse relationship is that farmers with small farms utilize their land more intensively than big farms, and thus produce more output. One leading interpretation of this correlation is imperfect factor markets (Benjamin and Brandt, 2002). The inverse relationship, if true, is closely related to problems of agricultural stagnation,
natural resource degradation, political instability, migration and poverty (Heltberg, 1998). While the dual labour market hypothesis is the more common explanation for the inverse farm-size productivity relationship, its universal applicability has been challenged on the lack of conclusive evidence (Squire, 1981; Heltberg, 1998; Kevane, 1996). These conflicting situations may be reconciled with the existence of price distortions in other factor markets (capital and land), which have countervailing effects (Feder, 1985; Kevane, 1996). Because it is an implication of imperfect factor markets, the inverse relationship for both output and labour has been cited as indirect evidence of imperfect labour markets. More recent studies emphasize, however that other market imperfections, such as credit constraints for small farms, may induce the inverse relationship. Instead of imperfect markets, the explanation may lie in agricultural technology. The most commonly suggested alternative explanation is that it is a statistical artifact, generated by omitted land quality (Benjamin, 1995; Heltberg, 1998). In the context of Africa, Dorward, (1999) investigated the farm size-productivity relationship amongst smallholder farms in Malawi. He found that an evidence of absent inverse relationship between farm size and productivity. Then, he explained this result in terms of failures in land, capital and produce markets with acute capital constraints, which affect both capital and labour inputs on smaller farms. Using data from Western Sudan, Kevane (1996) argued that, the labour market functions reasonably well but the insurance and financing constraints are the crucial market failures. However, Benjamin and Brandt (2002), using a Chinese data, found that, there is static
inefficiency in Chinese agriculture that can be linked to imperfect factor markets. They showed that, a considerable amount of inefficiency exists in the countryside, especially in the employment of labour. Also, with data from Pakistan, Heltberg (1998) had found strong inverse relationship between farm size and yield and the suggested market imperfections was consistent with his data. Benjamin (1995) with data from rural Java explained the inverse relationship to be due to omitted land quality. Whereas, studies of Lamb (2003) and Juliano and Ghatak (2003) explained the inverse relationship in terms of measurement errors, the imperfect credit markets and heterogeneity in farmer skills.

3.4 Labour markets in Africa:

Sub-Saharan Africa is still predominantly rural, with more than two thirds of the population and thus the labour force in the rural areas. Employment in urban areas covers a small share of the labour force. The urban labour market can be divided into formal and informal employment. Most of the rural labour force is engaged in agriculture or at least has agriculture as the main activity, as well as a wide range of other income sources (Bigsten and Toronto, 1997).

One of the institutions identified, as constraining African growth potentials is the African factor markets. The colonialists used legislations and other repressive policies to control the labour and capital markets and these policies continued after independence (Adenikinju and Oyeranti, 2000).

Are there labour markets in rural Africa? Clearly there are, they may not be perfect but they do exist. Moreover this, this
labour market is by no means restricted to the formal commercial sector, but is active in both the smallholder or peasant economy and the non-farm rural sector. But rural labour markets rarely appear in the form commonly recognized by economists, with a wide range of contractual arrangements and remuneration mechanisms (Leavy and White, 2003). Most work in rural Africa takes place on smallholdings, where the whole family works together and shares the returns from labour, land and other resources. Typically, households produce both for subsistence and for the market (Bigsten and Toronto, 1997). Labour markets are often described as thin or missing in many areas of the West African semi-arid tropics, although the empirical evidence for this is far less substantial (Lamb and Worthington, 2003). However; Bigsten and Toronto, (1997) argued that African rural labour markets are not perfect, but they are definitely not nonexistent.

Adenikinju and Oyeranti (2000) mentioned two competing views on how the African labour markets function. The first view sees a labour market that is competitive while the second view is non-competitive. They also argued that, empirical studies have found support for the tow competing views. Teal (1995) attributed those divergent views to the nature of the data employed, time series or cross-sectional. Tackling the equilibrium determination in the African labour markets, Adenikinju and Oyeranti (2000) stated that, in the formal market, the nominal wage rate is institutionally determined and it is above the market equilibrium wage rate. In the informal market, the wage rate is endogenously determined. In the rural labour market, the forces of demand and supply determine the wage rate. They added that, in both the informal and rural
market sectors; the household is the primary unit that determines both the demand and supply of labour, unlike in the formal sector where different agents separately determine the two decisions.

Agricultural labour markets in most sub-Saharan African countries are not fully developed and hence do not work perfectly. The main reasons for this are related to the peculiar production conditions surrounding agriculture (Smith, 1991). Two major factors, which have identified as affecting the efficiency of the labour markets in Africa is labour market segmentation and institutional factors (Adenikinju and Oyeranti, 2000). Studies in Egypt found that farm labour markets do not clear because of involuntary unemployment, segmentation, institutional rigidities and lack of information. (Bishay, 1990). In Kenya the rural labour markets appear to be highly segmented, a fact reflected by the significant lower wages and more elastic supply of labour (Jazairy et al, 1992).

3.5 Labour markets in Sudan:

In Sudan, many of the productive activities are organized not on market principles but on a more informal flexible set of arrangements that allow for self-employment as well as forms of non-market labour trading within and between households. This is true not only of the traditional agricultural sector in the rural areas but of many forms of urban employment (El-Bagir et al, 1984).

In Sudan, two distinct labour markets can be distinguished; urban and rural labour markets (Mohammed, 1987). The urban labour market is divided into formal and informal labour markets. The formal division comprises a sort of organized employment in
the public and private sectors, whereas, the informal one, involves unorganized employment highly dependent on family labour (ILO report, 1978). The urban labour market, both formal and informal, is competitive since the urban sectors attract pools of migrants with various academic qualifications and skills (Mohammed, 1987).

The population of Sudan, like that of most other developing countries, is predominantly rural. The main rural labour groups include traditional peasants, agricultural labourers, non-agricultural rural workers and nomadic pastoralists (El-Bagir et al, 1984). The rural labour markets represent the major source of labour required for investment in the urban sector (Mohammed, 1987). The evidence suggests that these rural labour markets function effectively to move seasonal labour in response to work opportunities (ILO report, 1978). Affan, (1977), cited in Mohammed, (1987) concluded that, there is increasing evidence that in the rural areas of the Sudan wage rates are determined by supply and demand. Kevane, (1994) in his study of rural labour markets in Western Sudan, concluded that, labour markets are well established, capitalist and competitive, contrary to conventional impressions that labour markets do not exist in villages of semi-arid tropics. Supply and demand affect rates and pattern of employment.

El-Jack, (1986) argued that, in Gezira scheme; a worker may work with a tenant today and change to another on the second day. The presence of numerous buyers of labour effort with the workers being well informed about other employment opportunities is essential for the existence of a perfectly competitive labour
market. Then he concludes that, the rural labour market in the Gezira is competitive, and it functions according to the forces of supply and demand. Research can not be satisfied with concluding that labour markets are widespread and competitive. It must ask how they are competitive and how they co-exist with non-market institutions (Kevane, 1994).

Fallon, (1994) lists the main characteristics of the Sudanese labour market in the following points:

• A high degree of mobility among unskilled labour between rural and urban areas.
• A high degree of mobility among skilled workers to jobs abroad.
• Public sector wages have fallen substantially behind those of workers in the private sector.
• A growing surplus among university graduates holding general academic qualifications.

Wage employment in rural areas occurs in two main sectors: in the large-owned and managed irrigated schemes and in the large mechanized farms. Labour is supplied to these sectors from several sources: local small scale farmers who supplement their incomes by seasonal wage employment, local landless labourers who may work both in agricultural and non-agricultural activities and temporary migrants who may be drawn from both of these categories and nomads (Fallon, 1994). Historically, Sudan has witnessed a process of commercialization of labour beginning in the early part of this century with labour recruited for irrigated agricultural schemes, and including the fairly recent emergence of
the use of hired labour in large scale mechanized rain-fed agriculture, along with the growth of urban wage employment (El-Bagir et al, 1984). In the mechanized sector, the main labour input is unskilled labour for weeding and harvesting during the two periods of peak demand (Fallon, 1994). For the unskilled workers in traditional agriculture, the evidence suggest that there are considerable variations in wage rates depending on seasonal factors and the demand situation of the labour market (Mohammed, 1987). The irrigated sector is of great relevance to the rural labour market as it employs a large proportion of seasonal migrants labourers (Fallon, 1994). The labour market in the irrigated area is only to some degree a local market. It has always been expected that the tenants would provide the main labour input to the tenancy, with additional help from paid labourers at demand peaks. It is this expectation and this obligation that forms the core mechanism of the labour market in the Gezira (El-Bagir, et al, 1984).

In relation to the existence of segmented labour markets in the Gezira scheme, it is worth mentioning that, the absence of agricultural workers’ trade unions and of minimum wage legislation as in the urban labour markets stands against the argument for a segmented labour market (El-Jack, 1986).

3.6 Non-farm labour market:

Diversification is the norm. Very few people collect all their income from any one source, hold all their wealth in the form of any single asset, or use their assets in just one activity. Multiple
motives prompt households and individuals to diversify assets, incomes and activities (Barrett et al 2001).

Ellis (1998) defined diversification as the process by which rural families construct a diverse portfolio of activities and social support capabilities in order to survive and to improve their standards of living. Economic studies distinguish between several different categories and sub-categories of income source when referring to diverse income portfolios (Reardom, 1997; Ellis, 1998). The primary categories are farm, off-farm and non-farm income sources (Saith, 1992 in Ellis, 1998). Farm income includes livestock as well as crop income and comprises both consumption in kind of own farm output and cash income from output sold. Off-farm income typically refers wage or exchange labour on other farms (i.e. within agriculture). It also includes labour payments in kind and other non-wage labour contracts. Non-farm income refers to non-agricultural income sources (Ellis, 1998). Nonfarm activities can be important sources of cash income, which can potentially improve farm productivity if is used to finance farm input purchase or longer-term capital investments. Nonfarm activities can also provide income during periods other than harvest time; help reduce the variance of overall household income in cases of imperfect covariance between farm and nonfarm income; and help mitigate risk and improve food security (Reardom et al, 1994; Reardom, 1997; Ellis, 1998). In Africa, most evidence shows that rural non-farm activity tends to be fairly evenly divided over commerce, manufacturing, and service sectors, to be linked directly or indirectly to local agriculture or small towns, and to be informal rather than formal (Reardom et al
In particular, off-farm activities are typically pursued by a majority of the rural poor, both because they lack access to sufficient land to make agriculture a viable income strategy, and because market failures for credit and insurance push them into off-farm activities to diversify their risks and seek sources of liquidity to be used in agriculture (Janvry and Sadoulet, 2001).

Farm household models assume that rural non-farm labour market is absent, but there is growing evidence that the rural non-farm labour market plays a substantial role in assuring food security (Leavy and White, 2003). The traditional image of farm households in developing countries has been that they focus on farming and undertake little non-farm activity. Nevertheless, there is mounting evidence that rural non-farm income is an important resource for farm and other rural households including the landless poor as well as rural town residents (Reardom, 1997). Farm households in modern environments engage in multiple productive activities. In addition to farming, rural workers also participate in wage-earning or self-employed activities, such as processing, manufacturing, construction, transportation and services (Yang and Mark, 2002). It is a well known fact of developing agriculture, that the predominant bulk of farm households are small cultivators, and therefore their resource base proves insufficient to gainfully employ them the year round even when production conditions are normal. Consequently, they fall back on the daily causal labour market whenever possible, such that off-farm labour income is often a fairly substantial contributor to total income (Kanwar, 1998). Outside crop production, households found alternative outlets for their labour, such as farm-related sidelines, family-run
businesses, and hiring-out off the farm, usually in local enterprises (Benjamin and Brandt, 2002).

The agricultural labour forces more mobile in most African countries, in part because farming families are used to combining off-farm work with farming activities. In much of sub-Saharan Africa the role of non-farm work is vital element in total household income (Yousif, 1985; Smith, 1991; Reardom, 1997). Households are motivated to undertake non-farm activities by either pull or push factors. The pull factors such as better returns in the non-farm sector relative to the farm sector, and the push factors such as an adequate farm output, an absence of or incomplete crop insurance and credit markets, the risk of farming and the failure of farm input markets (Yousif, 1985; Reardom, 1997). According to Reardom, et al (1994), several factors beyond the household characteristics and relative returns to agriculture condition the household’s participation in nonfarm activities:

- The physical environment: such as climate, infrastructures.
- The economic and institutional environment: including markets and government policies.
- The type of available nonfarm activities.
- Who controls farm and nonfarm activities within the household?

For the off-farm activities, Janvry and Sadoulet, (2001) mentioned that, participation by individuals in off-farm activities could be analyzed as a function of the characteristics of individuals, the asset position and the characteristics of the household to which the individual belongs, and the community
and regional characteristics of the community where the individual is located.

Smith, (1991) argued that, the time spent on farm work is relatively slight throughout tropical Africa, and involvement in non-farm work activities is common, even in times of maximum use of family labour. Reardom, (1997) estimated the average non-farm income shares in total rural income and employment to be 42% in Africa, 40% in Latin America, and 32% in Asia. In Rwanda, he found that, the highest income quartile of farm households earn substantial incomes in non-farm self-employment and then hire farm labourers mainly from the poorest households during the cropping season. Then he concluded that, non-farm income is a significant part of total income, hence it is important for purchasing power and food security. In the context of Latin America, namely in Mexico, Janvry and Sadoulet, (2001) found that, off-farm activities play a surprisingly large role in the determination of total household income among rural households. More than half of these households’ income on average derives from off-farm activities. In rural China, Benjamin and Brandt, (2002) found that the development of off-farm opportunities has helped considerably in eliminating constraints facing farm households. Then they added that, the labour market and other sources of off-farm employment are significant determinants of farm labour efficiency. Abdulai and Delgado, (1999) using data from Ghana estimated the non-farm work participation for men and women. They found that education, experience, infrastructure, distance to the capital, and population density, as well as interactions between education and infrastructure and between
education and distance to the city were found to be significantly related to the probability of non-farm labour market participation. Ahituv and Kimhi (2002) went further in modeling the relationship between off-farm work and farm capital investments. They found that when farm capital investments were enhanced by heavily subsidized credit, this prevented farmers from seeking off-farm employment opportunities. In many developing countries, between one-third and one-half of farm households derive income from off-farm sources, and off-farm income constitutes between 20% and 70% of total household income (Benjamin, 1992; Reardom et al, 2001). Using data from Western Sudan, Kevane (1994) found that, farm households earn much more from non-farm activities than from the farm labour market. Yousif, (1985) found that, families and family members, allocate labour and coordinate different tasks so as to maintain their standard of living. Then he added that, the phenomenon of multiple job holding is wide spread in Gezira scheme.

3.7 Labour markets and migration:

Migration is defined as a movement of human beings away from home, undertaken with the intention of finding employment (Grawert, 1998).

Most of the studies on migration in less developed countries are concerned directly or indirectly, with examining rural-urban migration. However, some studies deal with the transfer of labour from agriculture to industry during the process of development. These studies view the agricultural sector as a reservoir of surplus labour for the modern sector (El-Jack, 1986; Mohammed, 1989).
Labour migration, between and within urban and rural areas, has to be seen as a central element in the livelihoods of many households in developing countries, poor as well as rich. Much of the literature focuses on movements of people as a result of crises-environmental, economic or demographic. Yet migration is also a normal element of most if not all societies (Haan, 1999). The focus of research on migration tends to be on the supply of labour markets in towns, large scale agro-industrial or agricultural schemes and international centers of production and consequently, on the reasons why individual migrants leave their rural home areas. Such studies for the most part have been based on theories of migration in which agents seek income gains, and migration is viewed as a wage equilibrating mechanism (Rosenzweig and Stark, 1989; Smith, 1991; Grawert, 1998 and Leavy and White, 2003). However, Haan, (1999) argued that, insufficient attention has been paid to the institutions that determine migration. Population movements are not economistic reactions to push and pull, but the patterns of migration are determined by social and cultural institutions, embedded in local customs and ideologies (Haan, 1999).

Based on labour surplus notion, Todaro (1969) and Harris and Todaro (1970) modeled the rural-urban migration. These analyses assume that migrants act individually according to a rationality of economic self-interest. The decision to move to cities would be determined by wage differences, plus the expected probability of employment at the destination (Haan, 1999). Push-pull models of migration – as developed by Lee (1966)- are a logical extension of the Todaro-type of analysis (cited in Haan,
According to Todaro (1997) The pull and push factors could be summarized as fallow:

1. **Pull factors:**
   - The job availability in the region of destination
   - The search for better educational opportunities and improvement of skills.
   - The presence of friends and relatives in the destination area.
   - The attraction of city life, entertainment and welfare facilities.

2. **Push factors:**
   - Population pressures.
   - The pressure of rural poverty.
   - Climatic conditions.
   - To escape social and cultural imprisonment in a homogeneous rural life.
   - Rural violence.
   - The lack of job opportunities in the sending area.

In the tradition of Marxist analysis, the emphasis is on the structural nature of migration, not just the in the context of permanent rural-urban migration, but also with respect to the temporary migration of workers between rural areas (Haan, 1999). Regarding the Todaro’s model, El-Jack (1986) mentioned that the criticism that is leveled against this model is that; it assumes motives of migration completely economic, i.e. it omits non-economic factors. Considering the applicability of Harris and Todaro’s model in Africa, Smith (1991) argued that, most evidence suggests that there is little open unemployment in sub-
Saharan Africa, and the belief that African countries have been characterized by a large rural-urban income differential is questionable. Also, Lundberg, (1990) argued that, this model ignores the technological transformation of the labour sending agricultural sector. He further specified a three-sector, two-commodity general model, in which migration takes place from background agriculture to a modern agriculture and a modern manufacturing sector. However, Rosenzweig and Stark (1989) went further by assuming that a significant proportion of migration in low-income countries, particularly in rural areas, is composed of moves by women for the purpose of marriage. They support their hypothesis by the analysis of Indian data, concluding that, marriage-cum-migration contribute significantly to a reduction in the variability of household food consumption. Farm households afflicted with more variable profits tend to engage in longer distance marriage-cum-migration.

Many have now argued that both individualistic models such as Todaro model and migration analysis in the Marxist tradition have taken a one-sided point of view. So now the new economics of migration emphasize the family as a unit of analysis (Haan, 1999). In view of the debates that migration is a household-utility maximizing strategy; Bigsten (1996) using data from Kenya examined the migration patterns that rural households may choose in making the move from a rural to an urban area. His focus was on the circular migration; that is, the migration pattern whereby one member of the household moves to an urban area but does not leave the rural home permanently. The migrant retains ties with the family and returns to the rural area after staying in the urban area
for a while. However, Agesa and Kim (2001) also with data from Kenya, identified two distinct patterns of migration behaviour among rural migrants. In the first type, one member of the household (typically the household head) moves to an urban area first, while the rest of the family remains behind in the rural area to join him after a while. They referred to this type of migration as split migration. In the second type, the entire household migrates to the urban area as a family unit. They referred to this type as the family migration. They found that age, number of children, number of other dependents in the household, human capital skills, job security and the origin of the migrant household are major determinants of the decision-making between split and family migration. Migration by one person can be due to, fully consistent with, or undertaken by a group of persons, such as the family. Migration is seen as a form of portfolio diversification by the families. Migrants and their families enter into chosen contractual arrangements, in which remittances play an important role (Stark, 1991). Migration represents a potentially important source of income and savings through migrant remittances (Edward and Philip, 2001). Remittances are amongst the most important aspects of migration, especially so for the migrants’ areas of origin. Very little remitted money was invested in agriculture, to hire labour, buy agricultural materials or invest in livestock. The evidence suggests that the way remittances are used depends on the form of migration, the characteristics of the migrants and those who stay behind (Haan, 1999).

A well-developed literature addresses the question of migrant selectivity in the neoclassical and Todaro words by
merging migration theories with human capital theory, where wages at prospective migrant origins and destinations are assumed to be a function of individual’s skills. Then came the new economics of migration where continuing interactions between migrants and rural households suggest that a joint household model would be more appropriate than an individual level model of migration decisions (Edward and Philip, 2001).

Seasonal labour markets are a result of regional disparities and advanced commercialized agriculture, which requires large number of casual workers for short periods of time (Jazairy et al, 1992). The macro-context of rural seasonal migration is a version of the labour-surplus model where rural plantation agriculture dominates the economy rather than the urban industrial sector (Mohammed, 1989). Migration, particularly seasonal migration constitutes a major source of labour supply to the Gezira scheme. Migration both seasonal and permanent has been essential to Gezira scheme. The seasonal migration has the following characteristics:

- It is repeated for a number of years in the life spans of workers.
- It involves large numbers of workers.
- It occurs for a limited period of time.
- Most of migrants come as a result of the recruitment and preparatory campaigns of employers, particularly the Sudan Gezira Board and the administrations of other agricultural schemes. (El-Jack, 1986).
Mohammed, (1987) reported that, in Sudan, the rural labour markets represent the major source of labour required for investment in the urban sector. Then, using average earnings in both rural and urban sectors, he estimated the shadow wage rate, concluding that, the migration of labourers from rural to urban centers for employment is economically justified. Mohammed, (1989) traced the seasonal flow of labourers from areas of traditional agriculture to the Gezira area. He developed a model composed of family characteristics and origin and destination area attributes. He found that the wage rates and the household socio-economic factors have negative impacts in the degree of attachment in seasonal migration. El-Jack (1986) attempted to study migration in Gezira scheme in the context of the push-pull model. He concluded that, migration has been important to the Gezira scheme as it has played a historical role in the provision of labour to the scheme. The natural increase of the rural population will add to the supply of labour and is likely to offset any imbalances due to out-migration.

3.8 Agricultural wages:

The determination of wages, employment and output is central to economic analysis, and therefore the behaviour of the labour markets continue to be an important area of research both in industrially advanced economies and in poorer agrarian economies (Krishnan, 1991). According to conventional economic theory, forces of supply and demand are assumed to determine wages in a perfectly competitive labour market (Samuelson and Nordhaus, 1998). In relation to the
perfectly competitive market, there are certain assumptions, among them are:

- Workers and firms have perfect information about wages and job opportunities in the labour market.
- The labour market is composed of many individual firms on the buyer’s side of the market and many workers on the seller’s side.
- All jobs are open to competition by workers. (Kaufman, 1986 cited in El-Jack, 1986).

It is currently common to question the validity of the wage determination principle furnished by this conventional theory, particularly in cases of developing countries (El-Jack, 1986). Since the early days of development economics it has been widely believed that the normal apparatus of supply and demand cannot be employed to explain the process of wage determination in rural labour markets of poor agrarian economies. This belief was fostered by the acceptance of two stylized facts, namely, that the real wage was fairly inflexible and that, the wage rate generally exceeded the opportunity income of labour which was expected to be close to zero (Osmani, 1990). In development literature, Bardhan (1978,1979) and Radwan (1989) argued for the non-competitiveness of the rural labour markets in developing countries, whereas, the contributions of Hart and Sisler, (1978); Rosenzweig, (1980); Squire, (1981); El-Jack, (1986); Benjamin, (1992); Kevane, (1994) and Sharif, (2000) argued for the powerful role of forces of supply and demand in wages determination.
3.8.1 Theories of wage determination:

The analytical literature on employment, unemployment and wage determination in poor agrarian economies is large, albeit inconclusive (Bardhan, 1978). The existent literature presents a host of theories of rural wage determination such as the efficiency wage theories, the implicit contract theory and the subsistence theories (Kanwar, 1998). However, the classical thought of wage determination found its roots in the marginal productivity theory that, according to Polachek and Stanley, (1993) the only wage at which equilibrium is possible is a wage, which equals the value of the marginal product of the labourers. This theory received a lot of critics, among which, Bardhan, (1979,1984) argued that, the usual simple version of the marginal productivity theory is particularly incapable of explaining the persistence of unemployment among extremely poor farm labourers whose appetite for voluntary unemployment is not likely to be great. He found that, there is evidence that the wage rate, even though, is sensitive to demand pressures, does not adjust sufficiently to come anywhere near clearing the labour market. He added that, the theory also fails to take into account the monopsonistic or oligopsonistic power faced by the labourers. Polachek and Stanley, (1993) mentioned some objections against the marginal productivity theory, that the competitive process might work slowly and there is a difficulty of assessing the marginal product. Then they concluded that in practice, unique market clearing prices are rare, particularly for labour markets. The mere observation that supply and demand affect the wage rate is taken as a prima facie evidence in its support. This will clearly not do. What is needed is a theory of
wage formation that can simultaneously explain the existence of involuntary unemployment on the one hand and responsiveness to the forces of supply and demand on the other (Osmani, 1990).

3.8.1.1 The efficiency wage theory:

It has been noted that, there are both theoretical and empirical problems in using a simple framework of wage determination making wages a function of some indicators of demand and supply (Papola and Misra, 1980).

Better nutrition (food consumption and nutritional status) may contribute to higher labour productivity (per hour and total hours) and, conversely, higher productivity contributes to higher incomes (Strauss and Thomas, 1995). Rodger, (1975) observed that, for agricultural workers in India, an increase in the wage rate causes a reduction in employment and changes in wage rate are not reflected in family income per household consumption unit. He explained these observations by developing a theory of nutritional wage rate, which centered on the idea that the employer provides minimum nutrition to the workers to ensure optimal work efficiency and thereby minimizes average labour costs. Bliss and Stern, (1978) who attempted to test this theory, mentioned that, it is an appropriate theory for understanding the rural labour markets in developing countries. In part one of their paper, their result showed that, the efficiency wage theory when applied to workers of different consumption backgrounds concludes in both the competitive and non-competitive cases that wages are such that the marginal worker receives his efficiency wage. Then in part two, depending on some observations from India, they concluded
that, with many labour markets on a day to day basis and with wide differences in wages for apparently similar work, the theory does not have general applicability. They added that, where labour contracts are more permanents, that the theory is more convincing. However, Strauss, (1986) tested the productivity-consumption relation on the basis of Sierra Leone data. He found that, increased calorie consumption did significantly affect productivity. Aziz (1995) using data from India presented a household behaviour model to test the relationship between caloric intake of men and women and productive output on their farms. Van, et al, (1996), using data from Ghana, had addressed the possible interrelations between nutrition, labour productivity and labour supply within a non-linear simultaneous equations system derived from a utility maximization framework. They found that, hourly earnings of both men and women in Ghana respond positive to food consumption, negative to labour supply and positive to nutritional status. For nutritional status, they found that, it does not seem very sensitive to food consumption and labour supply decisions and the estimated effects are generally small, which may however be related to data limitations. With Indian data, Swamy (1997) has documented that rural wage levels in much of India are simply too large to be consistent with there being a nutrition-based constraint to labour force participation. Foster and Rosenzweig (1992) went further to test one of the assumptions of this theory that the individual consumption of workers is part of employers’ information. They reported that, the nutrition-based efficiency wage model has intuitive appeal because of its potential relevance to developing countries, where consumption levels are low and are likely to be
closely tied to income. Deolalikar (1988) estimated structural relationship for wage rates and a farm production function with nutritional intake and nutritional status of workers as explanatory variables. He concluded that the presented evidence clearly supports the importance of nutritional status in determining labour productivity in developing agriculture.

Among the critics against this theory, Bardhan, (1979; 1984) mentioned that, most of the standard theories of agricultural wage determination do not have much empirical foundation. He found that, the efficiency wage theory is empirically less consistent with his Indian data and it may be regarded as applicable more to the case of permanent labourers. However, Datta et al, (2004) mentioned that, while the efficiency wage hypothesis might be relevant in the case of wage rates of permanent workers, it seems implausible for casual workers. McIntosh, (1984; 1998) argued that, as a theory of agricultural wages, this theory has very attractive properties; yet it is fundamentally implausible for large sections of the labour market. It is not likely to be useful in explaining short-run wage behaviour and its validity does depend on the presence of asymmetries in the distribution of information about worker characteristics. Strauss and Thomas (1998) mentioned that there does not appear to be support for any of the wage diversity predictions of the nutrition-based efficiency model nor any obvious evidence of the phenomenon the theory was originally designed to explain, namely the coexistence of high unemployment rates and rigid wages in rural areas of low-income countries. Sharif, (2000) concluded that, the empirical evidence of serious deficiency in rural workers’ food intake coupled with wide
inter-household variation in the extent of that deficiency does not appear to support this theory. Moreover, the labour market conditions prevailing in developing countries have been observed to resemble those of a typical neoclassical economy, leaving the workers at the mercy of market forces to fight for their needs. However, Dasgupta (1997) argued that recent empirical criticisms of the nutrition-based efficiency-wage theory for poor countries have been off the mark because of their dependence on too literal an interpretation of the timeless model. Then based on data from nutrition science, he argued that, the timeless nutrition-productivity construct provides a metaphor, not so much for the phenomenon of involuntary unemployment, but for something else, namely an economic environment harboring poverty traps.

3.8.1.2 Implicit contract theory:

Economists usually assumed that labour is hired as a factor of production and is put to work like capital. There is however, one fundamental difference between labour and capital and that is, once capital is hired, it can be used or abused freely. In case of labour, when it is hired, a labourer management faces considerable restriction on how labour is used. Not only are there legal restrictions, but also the willing cooperation of labour itself must usually be obtained for the firm to make the best use of the labour services (Akerlaf, 1982). The origins of implicit-contract theory lie in the belief that observed wages and employment cannot be adequately explained by a competitive spot labour market in which wages are always equal to the marginal product of labour (Manning, 1990). Viewing labour market exchange in terms of
contract represent an interesting and moral methodological departure from conventional neoclassical models. A contract is a voluntary agreement that resolves the distribution of uncertainty about the value and utilization of shared investments between contracting parties. The contract specifies precisely the amount of labour to be utilized and the wages to pay. Wage payments in a contract reflect both allocative production decisions and risk sharing and income transfer decisions jointly determined by both parties (Rosen, 1985). The riskiness and the absence of, or limitations, on insurance and other intertemporal markets, beside the assumption of risk-averse agents in low income countries, are shown to account for the existence of important formal rural institutions such as share tenancy, permanent servant contracts and contractual interlining, mainly as means of reducing the riskiness of agricultural production (Rosenzweig, 1988). The basic idea of implicit contracts is that, in their dealings, employers are less risk-averse than workers and so it can be profitable for employers to offer workers an employment contract, which involve some insurance elements. For example, a contract may offer workers some insurance against fluctuations in their marginal product of labour, which, in a competitive labour market, would lead to fluctuations in the wage (Manning, 1990). Theoretical research on contracts has been propelled by recent developments in the economics of uncertainty and information (Rosen, 1985).

The implicit-contract theory is related to longer time periods, certainly longer than a single day (Kanwar, 1998). It is important to recognize that, part of the labour force works as attached labour and that there are contracts, which span several
seasons. The existence of such contracts may help to explain why those who are lucky enough to find employment on these terms are paid more than their marginal product in the slack season. But implicit-contract theory does not explain what type of worker will get a contract and why terms should vary across worker characteristics (McIntosh, 1984). Implicit contract theory was originally designed to explain the observed behaviour of labour markets. Various proponents of this theory have claimed that, it can explain wage rigidity and involuntary unemployment. But these are only predictions of the theory in certain special cases. Some doubts can even be expressed whether implicit or explicit contracts even exist (Manning, 1990). Osmani, (1990) argued that, the process of wage formation in rural labour markets is best seen as an implicit co-operation among workers aiming to achieve as good a deal as possible. Such implicit co-operation is self-enforcing in nature, sustained by the adoption of trigger strategies and made feasible by the repeated nature of the casual labour market. The efficiency wage theory and implicit contracts theories are probably irrelevant as plausible explanations of wage determination in the daily casual labour market, but they would make more sense in situations involving contracts substantially longer than a day (Kanwar, 1998).

3.8.1.3 The interlinked market theory:

Among the various theories proposed to explain the operation of the labour market in poor agrarian economies, the one based on the concept of inter-linked markets is employed to describe a situation in which the free operation of a labour market
is constrained as a result of various institutional linkages between the land and credit markets (Krishnan, 1991). An interlinked deal is one in which two or more interdependent exchanges are simultaneously agreed upon. Thus when a landlord agrees to take on a tenant at a fixed rent and also agrees to provide the tenant with credit at a certain interest rate, the landlord is entering in an interlinked deal (Basu, 2003). Labour services are exchanged for payments in kind and in money and sometimes for other labour in well-organized rural labour markets. Labour market outcomes are determined by linkages with other factor markets such as land and credit (Bardhan, 1979; 1984). The various contractual arrangements whereby employers offer wage advances, credit, inputs or land allotment involve a simultaneous transaction of land, labour, inputs and credit and they are also an example of interlocking markets with the terms of exchange in one market contractually tied to those in other markets (Leavy and White, 2003). One prominent cause of interlinkage is potential risk i.e. a market characterized by potential risk has a tendency to seek another market with which to get interlinked. Another explanation of interlinkage is the moral hazard problem, in which interlinkage emerges as a device for monitoring work effort (Basu, 2003). The theory of interlinked markets is confined to the permanent or tied labour and it is inconsistent with data from a daily casual labour market (Kanwar, 1998).

3.8.1.4 The subsistence wage theory:

It is usually thought in the development literature that the wage rates in the rural areas of developing countries are
determined by subsistence requirements (El-Jack, 1986). The bases for Lewis’ horizontal supply function are surplus labour and an institutional wage rates. It postulates that the developing countries have unlimited supplies of labour in the traditional sector, and that workers are paid an institutional wage rate which affords them their minimum subsistence income. This wage rate is considered to be a social datum much above their marginal productivity (Sharif, 2000). Economists in the classical tradition adhere to the notion of surplus labour i.e. the presence of disguised unemployment, with wages for a time determined institutionally in a bargaining context (Ranis, 1997).

The belief that very low-income levels generate specific labour market conditions has led some to argue that in traditional agriculture, a conventional unchanging subsistence wage is offered despite the existence of surplus labour (Rodger, 1975). This theory hypothesized that, real wages are determined for the most part by factors that are exogenous to the labour market, such as cultural, social, biological or moral norms. In other words, this theory may be interpreted to predict that changes in labour market conditions have no effect on wage rates (Kanwar, 1998). Bardhan (1979; 1984) critically argued that there is, however hardly any economic theory of wages here, and in any case, its implication of wage constancy in the face of demand and productivity variations is not borne out by the data. As forces of agrarian capitalism and commercialization gather strength and erode traditional patron-client relationships, age-old customs often have a way of adjusting to economic changes. Rosenzweig (1978) mentioned that, the subsistence or institutional wage models offer no theory of how
rural wage levels or differentials are set. Kanwar (1998) argued that, the so-called subsistence theory of wages is not supported by econometric evidence. However, Ranis (1997) compared between the classical view of institutionally determined wages and the competitive neoclassical view of wage determination in the context of developing countries, concluding that, while the notion of an institutional wage may be troubling to some economists, the empirical reality of its existence and validity is difficult to deny. The neoclassical findings do not contradict our view of an institutional real wage gradually yielding to a competitive real wage in the context of the dualistic economy.

Since Arthur Lewis advanced his surplus labour hypothesis, the main focus of research has fallen on wage determination. We have no intention of minimizing the contribution of wage determination theories, but in many poor agrarian economies labour markets are in the process of evolution, that the determinants of returns to labour are too complex to be explained by markets alone (Radwan, 1989).

**3.8.2 Wage functions:**

In a competitive economy, wages should act as guideposts informing people which occupation to take (Polachek and Stanley, 1993). Wages vary considerably and are not uniform across workers or villages or the agricultural season (Kevane, 1994). In dealing with the relationship between labour hiring and returns to labour, the role of non-market and extra-economic factors is crucial in determining labour incomes (Radwan, 1989). Traditionally much labour exchange in the smallholder sector has
been on a reciprocal basis, or using non-cash payments. Commercial framing, on the other hand, is characterized by a more straightforward market relationship (Smith, 1991). In poor agrarian economies, the market forces play a fuller and harsher role than in a developed economy, as minimum-wage legislation is much less effectively, if at all implemented, unionization of rural labour is rare, and the state does not pay unemployment benefits. The agricultural labour force is also relatively homogenous, and illiterate and unskilled workers perform most operations. All these factors prompt some economists to regard agricultural wage and employment as determined by forces of supply and demand in a competitive market (Bardhan, 1984). An explanation of wages and employment will, consequently, be improved by turning to a more individualistic approach and that it is not enough to say that wages and employment are determined by the supply and demand for labour. Much more detail on the behaviour of the individual agents is required. It is fairly clear in the literature that landlords exercise some power over labour (McIntosh, 1984).

Papola and Misra (1980) estimated wage equations for male and female agricultural workers, using data from India, putting the wage rate as independent variable and the dependent variables used were; surplus labour, alternative employment opportunities, yield, cropping intensity, irrigation, mechanization, crop pattern and land distribution. Among their results, surplus labour, work opportunities in non-agricultural sector and pattern of land distribution are mostly significant in explaining male wage variations. Variations in female wage rates were found to be explained by number of female workers per 100 hectares,
alternative employment opportunities and percentage of agricultural labour in rural population. Rosenzweig (1978) formulated an equilibrium model of rural wage determination, using Indian data. He assumed a labour market composed of two types of labour, male and female and three agricultural households, a landless household and two households with different plot sizes, small and large. The market is initially assumed to be competitive and wage rates are determined endogenously. His result appeared generally consistent with the competitive market model. Bardhan (1979) estimated wage equations for casual and regular farm labour in India, with the daily wage rate and the monthly salary, respectively, as dependent variables. The independent variables used were; per capita land cultivated, age, the number of dependents per household, an index of agricultural development, a weighted-average unemployment rate and five dummy variables representing women, irrigation use and the remaining three dummy variables for different seasons. He found that, for the casual labour, the wage rate is positively associated with the irrigation use, the agricultural development index, age of the worker and the busy season of the year, and negatively associated with the slack season and the unemployment index. For regular labour, it is found to be positively responsive to crop intensity, the development index, the age and land cultivated and negatively associated with the number of dependents per household. McIntosh (1984 and 1998) developed a wage model in which the demand side of the labour market is described by a small number of oligopsonistic wage setting farms facing a large number of passive individuals with specific characteristics searching for the highest
wage. He concluded that, the model and its properties justify the emphasis on market forces as an explanation of agrarian wage and employment determination. Moreover, its properties and predictions agree with what empirical research found in the agriculture of developing countries. Kanwar (1998; 2004) estimated wage functions for male, female labour of both cultivator and landless households. The regressors include various personal and household characteristic variables as well as demand-side and productivity variables. The results showed that, for the cultivator households, the most significant variables were; the crop price, education, cast status, number of dependents per household and non-land assets. For landless households, the significant variables were; family size, non-land assets and net revenue.

3.8.3 Agricultural wages in Gezira Scheme:

Labour in the Sudan was and is often mobilized through institutions that serve purposes other than maximizing the economic rewards to the particular individual doing the work or hiring the labour. Wage labour transactions are complex phenomena, embedded in broader patterns of social relations and conflicts (Kevane 1994). The coexistence of daily-wage and piece-rate contracts is a widely observed feature of labour markets. A daily-wage contract usually involves working at a given pace of work for a fixed wage and a fixed number of hours, all of which are identical across employers or labourers. Under a piece-rate contract, the labourer chooses his or her own preferred pace of work and length of the workday, and is paid according to the amount of work completed (Baland et al,
Agricultural wages in Gezira Scheme take the form of piece rates rather than daily rates. These piece rates are linked to the intensity of the specific agricultural operations i.e. the number of days or hours needed to perform an agricultural operation per unit area. Also, these piece rates are influenced by the supply and demand situations. Wages are determined through bargaining but in some cases either the tenant determines the wage value or the worker dictates his price. Generally, in cases of inadequate labour supply, the worker finds himself in a position to dictate the wage.

In their analysis of daily wages and piece rates in agrarian economies, Baland et al, (1999) found that piece-rate contracts may be better compared to the daily-wage contracts, because they represent a mutually beneficial arrangement which gives labourers the freedom to choose their own pace of work and obviates the need for supervision. However, when there is competition among employers, both contracts coexist.

Generally, many studies of agrarian economies have called attention to the presence of both cash and kind components in agricultural transactions (Bliss and Stern, 1982; Bardhan, 1984; Binswanger and Rosenzweig, 1984; Rosenzweig, 1988; Datta et al, 2004). A standard argument is that, with perfect markets and costless transactions, the most efficient payment is in the form of cash. But, in situations where markets for some goods do not exist or are very incomplete, and self-production is costly or infeasible, many have interpreted the kind share as a proxy for wages (Alston and Kauffman, 1998 cited in Datta et al, 2004). The essential item of wages beside the piece rate is the provision of food especially for migrant workers. This is in addition to other items, such as
pastures for the labourer’s animals and cash advances. There is a problem of assessing wage levels, due to these different elements involved in the formation of wages in Gezira Scheme (El-Jack, 1986). However, Bliss and Stern (1982) argued that employers provide farm workers with meals to save on time lost in having the workers return home for their meals.

While it is true that wages vary systematically over the season, it is not true, therefore, that the market mechanism has failed to function in the Gezira (Fallon, 1994). In Gezira seasonal variations in the demand for labour do exist. Two peak periods were distinguished, one at the beginning of the season and the second one at harvest times. So wage rates varied substantially between the peak and slack periods. Seasonality also implies that terms and conditions of labour hiring are usually quite different in the peak period from other times of the year (El-Jack, 1986).

3.8.4 Sharecropping in Gezira Scheme:

Otsuka et al, (1992) described the production environment in developing economies in the following points:

- Uncertainty regarding both output and its market price.
- Absent formal insurance markets
- High costs of labour employment that limit the use of hired labour.
- The difficulty in monitoring hired labour specially in more complex farming systems.
- In the peak of labour demand, labour is commonly employed under a daily wage contract.
The mobilization of labour for commercial agriculture has led to a whole range of employment models and contractual arrangements. Farm workers may be employed by the day or by the task, there can be systems of shared crop, shared time, combinations of cash and payments in kind, or rights to use of land (Smith, 1991). There has been considerable attention to the contractual terms associated with the rental of land in the development literature. The relevance of the tenancy contract is that such contracts may influence the allocation and returns to labour. Tenancy contracts are an important rural institution in many low-income countries (Rosenzweig, 1988). Landowner may lease his land to another party, a tenant, or he may become an employer by hiring workers to farm his land. In this way, a land tenancy contract and a labour employment contract are alternative ways of exploiting resource endowments in an agrarian economy (Otsuka, et al, 1992).

According to Eswaran and Kotwal (1985), there are three types of explanations that have been offered for the existence of different tenurial contracts:

- Tradeoff between risk sharing and transaction costs.
- Screening of workers of different qualities.
- Market imperfections for inputs besides land

The share or sharecropping is defined as the land rental arrangement by which rent is paid from the share of output produced from the rented land. It is similar to the piece-rate labour employment contract in that the worker is rewarded in proportion to the output he produces (Otsuka et al, 1992). Sharecropping is a widely diverse phenomenon. It has existed in various times under
widely different circumstances and in several forms. A single theory can not explain all the aspects of share tenancy. That is why in the literature we find alternative explanations of share tenancy each highlighting some specific aspect of it (Ray, 1999). Share contracts allow farmers to have labour on tap within their compound, which is highly desirable where their seasonal requirements are peaked, unpredictable and where timing is vital (Smith, 1991). Sharecropping tends to be regarded as an interesting theoretical puzzle by neoclassical economists and as an oppressive form of exploitation by Marxian economists. The link between these two angles is found in the concept of interlocked factor markets, which refers to the lack of independence between different input markets when multiple transactions are tied together in a single tenancy contract (Ellis, 1993). The use of sharecropping as a form of labour contract is widespread in the Gezira scheme. In the sharing arrangements in the Gezira, the tenant provide the land, the seeds, pay all the tractor work costs and the land and water charges, and in some cases he pays half the cost of harvesting the crop. The sharecropper, on the other hand, is responsible for other expenses such as all the labour needed in the cultivation of the crop (El-Jack, 1986).

There are two opposing competitive models of sharecropping, one which views production behaviour from the viewpoint of the tenant, the other from the viewpoint of landlord. The tenant model gives the tenant control over resource decisions, subject to the payment of the agreed crop share to the landowner. The landowner model gives the landowner controls over resource decisions including the number, size and crop share of each
tenancy (Ellis, 1993). Many tenants in Gezira Scheme enter into sharecropping arrangements with their labourers. From the perspective of the labourers, sharecropping provides a means of gaining access to land either for cash or subsistence cropping, without having carried the burdens associated with the tenancy agreement. In many cases, the tenant is indebted to the labourer, and repays the debt by entering into sharecropping arrangement (El-Bagir et al, 1984). The fears that usually raised by the Board against sharecropping arrangements in the Gezira are based on the supposition that once a labourer gets a chance of sharecropping, this will restrict his participation in farm work. Nevertheless, it needs to be pointed out that, sharecropping instead of restricting workers’ participation may encourage or increase it, because the worker as a sharecropper is also supplying labour to farm work in the scheme. His preference for sharecropping over wage earning seems rational in so far as the former yields to him higher returns than the latter (El-Jack, 1986). When farmers are faced with the problems of liquidity to pay for the hired labourers who require assurance with regard to payment, the outcome of this situation, is often a sharecropping contract with the labourers. Usually crops shared are dura and groundnut (El-Bagir et al, 1984).

One plausible explanation for sharecropping seems to be risk aversion in an uncertain environment and the presence of incomplete or imperfect markets. The reasons for practicing sharecropping are the imperfect labour markets, the incomplete or non-existent markets and the incentive and monitoring problems (Ellis, 1993). Agricultural output is risky. Farmers can seldom buy insurance against these risks. In sharecropping, the risk of output
fluctuations is shared between the landlord and the tenant (Stiglitz, 1988).

The main reasons for sharecropping among the Gezira tenants are summarized by El-Jack (1986) as follows:

- Problems of labour shortages and the refusal of labourers to work as wage earners.
- The high labour intensity of some crops.
- The risk-sharing characteristic of sharecropping.
- The inability of the tenants to finance or secure cash for hiring labour.

There are two basic approaches in modeling sharecropping contracts. The first assumes a prohibitively high cost of monitoring the tenants’ activities (inefficiency of sharecropping). The second approach is based on the monitoring ability of the landlord on tenants’ labour work. However, the existing empirical evidence is inconclusive in judging the validity of either approach (Shaban, 1987). The sharecropping models simply postulated that, from the tenant perspective, sharecropping is inefficient, while it is efficient from the landowner’s point of view (Ellis, 1993). Ray (1999) have explored the possibility of the existence of share contracts as a response to imperfections in the labour market. In the context of Gezira, there is the possibility of inefficiency of sharecropping arising from an under-supply of labour as predicted by the traditional theory of sharecropping (The tenant model). The reason for this is that the sharecropper is left to
himself and there is no amount of labour specified to him to supply (El-Jack, 1986).

3.9 Market demand and supply of labour:

3.9.1 Measurements of labour inputs:

Workers are more than abstract factors of production (Samuelson and Nordhaus, 1998). The term labour describes the effort of human beings, including that of farmers, their families and the hired workers; Labour is defined as the work done by human beings and not the persons themselves (Upton, 1987).

Labour, like capital, can be defined either as a stock of productive instruments or as a flow of services. In the stock sense, labour is the totality of people counted as in the labour force. In the flow sense, labour is the number of man-hours available for production over a period of time (Reynolds, 1982). Since labour is the effort of human beings and not the persons themselves it should therefore be measured as a flow over a given period of time. Work inputs are usually measured in man-hours or man-days, which is simply the product of the number employed and the time worked by each (Upton, 1987). Man-day is a common measure of labour input and is based on the amount of the productive work that the average adult male worker can perform within an eight hours period. Since men, women and children differ in their physical productivity; the need arises for establishing a common denominator as a basis for comparison (Mohammed, 1979). Conversion factors have been suggested for representing work done by women and children in man-hours equivalents (e.g. women two-thirds and children one-third), but these are essentially
arbitrary methods for aggregating different types of labour into a single total (Upton, 1987). In the conversion of labour inputs into man-days, there is no fixed rule to follow. The basis for conversion varies from one study to another and it appears that, the type of rural economy in each situation to which the size and kind of participation of these categories is related, plays a role in the choice of conversion factors (El-Jack, 1986).

Erkus, et al (1990) in their study of labour use in Turkish agriculture used the following coefficients:

- 0.5 for girls and boys aged 7-14 years.
- 1.0 for men aged 15-49 years.
- 0.75 for men over 50 years.
- 0.75 for women aged 15-49 years.
- 0.5 for women over 50 years.

Sidhu and Grewal (1990) in India, used conversion factors of 0.67 for women and 0.5 for children. For rural Africa, Upton (1987) suggested conversion factors of 1.00 for adult males, 0.67 for adult females and 0.33 for children. In Sudan, Mohammed (1979); El-Amin (1981); Gussm El-Seed (1983); El-Jack (1986) and Babikir (1998) assigned conversion factors of 1.00 for adult men, 0.75 for adult women and 0.5 for boys and girls.

In general, the hours worked per year in farming tend to be lower in arid regions because of the short growing season. There are various possible factors for this low labour input, such as the climate, health and nutritional status of the family members, the time spent walking to the fields and to the markets, the Seasonality of farm work, leisure activities and off-farm work (Upton, 1987). Benjamin (1992) found that, in Java, the household members
supply about 275 person days per year to agricultural activities. Erkus, et al (1990) suggested about 268 workdays per year in Turkey. In Africa, Upton (1987) stated that, adult males spend between 500-1500 hours per year on their farms, compared with 2500-3000 hours worked in Egypt and other regions where irrigated agriculture is prevalent, and in urban industry. In Sudanese irrigated agriculture, averages of 200-250 man-days per year were suggested by Mohammed (1979); El-Amin (1981); Gussm El-Seed (1983); El-Jack (1986) and Babikir (1998).

Hours of work per day as well as the working days per month are not fixed but vary depending on many factors (El-Jack, 1986). Length of the day, in Africa, varies considerably over the year and between sexes. It varies among areas and according to the age of the farm worker. Disparate workdays are also related to different crops and operations on these crops. The more intensive the work effort, the shorter the daily work period.

The peasant cultivator has his own micro-scale of time associated with the hours of the day, related to conditions of light, temperature and moisture which influence, on the one hand, the physical discomfort of the labourer and on the other, the amount and kind of work permitted by the conditions of fields (Cleave, 1974). Using data from some Egyptian villages, Datt and Olmsted (1998) found that, the working day in agriculture dropped from eight to six hours per day due to migration opportunities and the development of nearby industrial centers. In other African countries, Cleave, (1974) reported average working days of 4.8, 5.6, 6.2 and 4.6 hours in Nigeria, Ghana, Zimbabwe and Uganda respectively. El-Jack (1986) argued that, in Sudan with an
equatorial severe hot climate, it seems appropriate, on average, to accept that the length of the day to be even hours. He also assumed that the working days per month were twenty days. However, a working day of eight hours and twenty-five days per month were assumed by Mohammed (1979); El-Amin (1981); Gusse El-Seed (1983); Ahmed (1986) and Babikir (1998).

3.9.2 The demand for agricultural labour:

While a lot of research has been done on issues concerning the supply of labour both in the context of developing as well as developed agriculture, relatively little empirical evidence seem to be available on issues concerning the demand for labour (Kanwar, 1998).

Demand for a particular kind of labour is derived from demand for its product and is related to the productivity of the labour in question (Reynolds, 1982). The demand for labour is much more of a technical relationship as compared to the supply of labour. This follows from the fact that, it is a derived demand arising from the demand for the products that it enables to be produced (Kanwar, 1998). The demand for labour is a function of the characteristics of demand in the product market (Ehrenberg and Smith, 1982). It depends not only on the physical output that can be obtained by employing additional labour for either current or capital activities, but also on the amount of output that can be sold and the price it will fetch (Booth and Sundrum, 1985).

3.9.2.1 The determinants of agricultural demand for labour:

The determinants of demand for labour attracted greater attention in the early literature than the determinants of supply,
with the development and refinements of marginal productivity theory (Sapsford and Tzannatos, 1990).

According to the neoclassical theory, the demand for labour is a function of the wage rate, because farmers seeking profit maximization will hire that amount of labour whose marginal product equals the prevailing wage (Booth and Sundrum 1985; Polachek and Stanley 1993). The amount of labour input over a given period on a particular farm, depends upon the family structure, the number of hours worked and the rate of working per hour (Upton, 1987). The demand for labour may be seen to arise as a result of the complex interaction of several categories of technological and non-technological factors. Among the technological factors, there are: the type of irrigation, fertilization and the use of high yielding varieties of seeds, farm implements and machinery and institutional conditions such as unusual climatic and soil characteristics and the effect of tenancy on labour use. The non-technological factors are the demographic variables such as the family size, the age and sex composition of the family, land and non-land household resources, household head age and education (Bardhan, 1984; Kanwar, 1998). However, Booth and Sundrum (1985) mentioned that, among the factors influencing agricultural labour demand are: the season of the year, the available cropped area and its quality and the adoption of technology. They also added that, generally, both demand and supply may be influenced by various factors other than wages, such as demographic conditions and the size distribution of holdings.
3.9.2.2 Some empirical studies of agricultural labour demand:

Balcombe and Prakash (2000) using time series data from England estimated a labour demand function for agricultural workers. First, an aggregated production function for the United Kingdom agriculture was derived, then the demand for labour was derived depending on the assumption that profit maximization under perfect competition requires that the marginal product of labour is equal to the real wage. Using a two-simultaneous equation model, Sidhu and Grewal (1990) estimated labour demand functions in rural India, where labour employment equation and output equation were estimated simultaneously based on the fact that, the level of production on the farm depends upon the use of labour which also depends upon the level of output. The dependent variable is per hectare human labour used and farm size, use of pesticides, use of weedicides, irrigation intensity, level of production, wage rate and source of draft power were the independent variables. Most of these variables significantly affect labour demand. With data from India, Bardhan (1984) found that, hired labour demand is positively associated with the multiple cropping index and negatively associated with both wage rates and the number of adult workers in the family. Benjamin (1992), using data from rural Java, estimated agricultural labour demand functions using ordinary least squire method. The dependent variable was the person days employed and the independent variables were a group of technological and demographic variables. Among his results, was that, the wage rate has a negative effect on labour use whereas soil quality, type of irrigation, education and fertilizer and pesticides prices was found
to have a positive significant effect on labour demand. Using data from Uganda, Bagamba et al. (2004) estimated labour demand function for banana production using Ordinary Least Square regression. They found that, labour use responded negatively to wage rate, nonfarm self-employment and distance to paved roads. They also found a positive response between labour use and education. The joint effect of household characteristics on labour use was significant implying that the separability condition between production and consumption decisions is not valid. Also, by the use of ordinary least squares regression method and data from India, Skoufias (1993) estimated male, female and total labour demand functions for agricultural workers. He found that, labour demand is responsive to changes in the respective wage rates and irrigation use has a significant effect on labour use. Kanwar (1998) with data from agricultural households in India estimated labour demand functions by the use of ordinary least squares method. The total worked days was regressed against a set of technological and demographic variables. The wage rate was found to have a highly significant negative effect on the demand for both total and hired labourers. The household composition variables had insignificant effect on the total demand for labour, whereas, these variables had significant effect on the demand for hired labour. The percentage of irrigated area and area cultivated had a very strong positive effect on both total and hired labour demand.
3.9.3 The supply of agricultural labour:

3.9.3.1 Introduction:

It can be argued that the fundamental scarce resource in the economy is the availability of human time, and that the allocation of time to various activities will ultimately determine the relative prices of goods and services (Juster and Stafford 1991). The total time can be divided into consumption time or leisure, homework and market work (Polachek and Stanley 1993).

When properly defining what it means for a person to supply his labour, we consider two competing definitions that he actively searches for work and that he will accept a job if a job comes his way (Basu et al, 1998). In the language of modern household economics, the time of household members is a resource or factor of production. For poor households, it represents the dominant household resource. It will be allocated to several activities in such a way as to minimize the cost of producing household goods (Evenson 1979). If a person works, he can earn a wage which yields an income that can be applied to derive satisfaction to utility from the goods and services, which this income can acquire (Todaro 1997). Labour supply deals with how much leisure individuals are willing to give up at any wage. Giving up leisure entails work, and work implies earnings (Polachek and Stanley 1993). However, leisure is produced simply by not allocating household time to production or to wage work (Taylor and Addelman 2003). Leisure itself can be considered an economic good to the extent that its consumption also yields a
certain satisfaction. But the price of leisure is the opportunity cost, or the foregone income of not working (Todaro 1997).

3.9.3.2 Basic labour supply model:

Both theoretical and empirical work on time allocation traces its roots to Becker (1965) who first formulated a utility maximizing model of commodities which were produced by both time and market goods inputs. He states that, the heart of this theory is an assumption that households are both producers and consumers; they produce commodities by combining inputs of goods and time to maximize a utility function subject to prices and a constraint on resources. This model has been widely used to analyze choices of hours worked and later extended to include home production and leisure (Fafchamps and Quisumbing 2003). Becker’s model integrated the production, consumption and labour supply decisions within a household framework and proved to be very influential in the labour supply literature (Sapsford and Tzannatos 1990). Several specifications of the utility function have been used in the labour supply literature (Lanot and Muller 1997).

Evaluating and interpreting labour supply estimates requires economic models to provide a context for comparison. Estimates often diverge simply because studies focus on evaluating behavioural responses corresponding to different wage and income effects (Blundell and MaCurdy 1999). The standard labour supply model assumes that the individual maximizes his utility function (U), defined as the amount of market goods (C), which are assumed to be a composite commodity and hours of leisure (L),
consumed per period, subject to income and time constraints, that is:
Max., U (C, L), where; the income constraint is defined as:
PC = WH + V, where:
P is the price of a unit of C, W is the wage rate per hour and V is other labour income. Total available time may be allocated between leisure (L) and work (H): T = L + H. (Rosenzweig 1980; Schultz 1982; Blundell and MaCurdy 1999; Polachek and Stanley 1993; Maglad 1998).

This model has been extended to interpret the labour supply in a family context, on the assumption that the family is a single decision making unit. But it was criticized as it treats all individuals in the family as a single decision making unit rather than as if they were a collection of individuals (Blundell and MaCurdy 1999). Hanoch (1982) listed some statistical problems that encountered labour supply estimation, among them are:

- The simultaneity bias in regression estimation of labour supply.
- The participation selectivity bias.
- The discontinuity of supply or the existence of minimum supply quantities.
- The survey-week selectivity bias.

Whenever decision making occurs at the level of the household, it is natural that what is expected to happen to one person in the labour market will affect the behaviour of other members in the household (Basu et al, 1998). Also the family labour supply approach could be criticized with regard to the customary division of tasks and roles between men and women.
Male and female workers are not expected to respond in similar ways to changes in the wage rate (El-Jack 1986). In developing countries where households are large, with multiple tasks and participants, there is sufficient room for specialization and plenty of scope for preferences and social norms to fashion what individuals do (Fafchamps and Quisumbing 2003).

3.9.3.3 The development of the basic labour supply model in the context of agricultural household models:

The large majority of rural households in developing countries organize their production activities within the household (Bardhan, 1984)). Becker recognized the household as the relevant decision making unit regarding the related questions of labour force participation and hours of work decisions, on one hand, and home production and consumption decisions, on the other. Most households in the developing countries produce partly for sale and partly for their own consumption. They also purchase some of their inputs and provide some from their own resources (Singh et al, 1986).

Household farm models are a useful tool to study how household-specific transaction costs shape the impacts of exogenous policy and market changes in rural areas. They incorporate a farmer’s interaction with outside markets and are a source of testable implications regarding these interactions (Benjamin, 1992; Taylor and Adelman, 2003). The uses of these models included applications to such diverse topics as off-farm labour supply, technological policy, nutrition policy, labour supply, migration, income distribution, saving and family planning
(Taylor and Adelman, 2003). They are often used in developing countries to analyze household labour allocation in agriculture since they incorporate both the consumption and production aspects, they capture the essential considerations underlying the allocation of family time between leisure and work and they provide a framework for understanding household participation in labour market as suppliers of family labour or as employers of hired labour (Sicular, 1986).

The standard, static household production model is well expounded in the literature (Kanwar, 1998). Becker (1965) developed a theory on time allocation within the household, which was complemented after that by many contributions that led to what is known as the new home economics.

The classic model of the peasant household is due to Chayanov (Leavy and White, 2003). The Chayanov model is a theory of household utility maximization which focuses on the subjective decision made by the household with respect to the amount of family labour committed to farm production to satisfy the consumption needs (Ellis, 1993). Chayanov emphasized the role of demographic composition as a determinant of the subjective equilibrium for peasant households where there was no labour market. For these households, the level of farm labour and farm output depends on family size (Benjamin, 1992). El-Jack (1986) argued that, what is important in Chayanov’s model is the concept of demographic differentiation that links the farm family labour input with some demographic variables. Then he added that, the assumption of no labour market in this model is not valid to many peasant societies where there is considerable hiring-in
and-out of labour. However, Leavy and White (2003) mentioned that, later models have relaxed this assumption. For instance, Barnum and Squire (1979) demonstrated that households may be net buyers or sellers of labour. The perfect markets neoclassical model assumes that all markets exist for the household and all prices are determined exogenously in these markets. Households, like countries, are better off with access to markets than without. Intuitively, missing markets impose constraints on households, and removing constraints logically can not make households worse off than before (Taylor and Adelman 2003).

Many empirical contributions of the farm household models were found in the development literature: Barnum and Squire (1979); Evenson (1979); Singh et al (1986); Lopez (1984 and 1986); Benjamin (1992); Pit and Rosenzweig (1986); Thapa (2000); Taylor and Adelman (2003).

A fundamental trait of the perfect markets models is that, it is separable or recursive. That is, production decisions are independent of consumption decisions. This distinguished the perfect markets model from the missing markets model, when in one or more markets, production and consumption decisions are simultaneous, rather than recursive (non-recursive) the model is non-separable. In general, a market is missing if the costs of participating in it are so high that self-sufficiency is the household’s optimal strategy (Taylor and Adelman 2003). The sufficient condition for recursiveness is that all markets exist for produced and consumed commodities; with the household being a price-taker and those commodities are homogenous. Historically, non-recursive agricultural household models were thought to be
relevant, primarily because labour markets were presumed not to exist. But in rural labour markets of developing countries, this assumption has become increasingly questioned. This does not mean that empirically relevant models have to be recursive, but the reasons for non-recursiveness need to be clearly spelt out (Singh et al 1986).

Benjamin (1992) tested for the separation (recursiveness) of agricultural household models using data from rural Java, based on the assumption that, in the absence of labour markets, household composition is an important determinant of farm labour use. He concluded that, I couldn’t reject the null hypothesis that farm labour allocation decisions are independent of household structure. Lopez (1984, 1986) provided the first explicit test of non-separation, using Canadian data. He argued that, the empirical literature on measuring the behavioral responses of farm households has typically used recursive models, but there are several situations for which recursive procedure may not be appropriate. He concluded that, the hypothesis that production and consumption decisions are independent was rejected and it was shown that important gains in explanatory power result from estimating the consumption and production sectors jointly.

3.9.3.4 The determinants of agricultural labour supply:

Little research has been conducted on the factors that influence labour supply for work on farms. According to Bardhan (1984), market agricultural labour supply seems to be primarily determined by the wage rate and other economic, social, and demographic constraints. Broadly, Yousif (1985) mentioned that,
farm labour supply is influenced by; the demographic structure and composition of farm population, educational level, exodus from farms, multi-dimensional structure of the employment and socio-cultural and institutional factors.

The following points reviewed the determinants of farm labour supply:

3.9.3.4.1 **The demographic structure and family composition:**

The decisions of farmers to work on or off the farm depend, in part, on household composition and the participation patterns of other family members (Kimhi 1996). The labour supply is influenced by the demographic structure and composition of the family in terms of age, sex and size, and by the family demographic behavior in terms of fertility, mortality and migration (Yousif 1985). In rural Africa, although some labour is hired, the core of the farm workforce is made up of family members. The size of farm, or of livestock herd, depends upon the number of active family members (Upton 1987). The social structure of the tenant and his family is regarded as an important factor that influences the tenant contribution to farming activities (Mohammed 1979). Production, consumption patterns and making of decisions are partially affected by the size, age and sex distribution of the farm household family members. In the Gezira scheme, it was noticed that, the size and composition of the tenant’s families are very important factors in shaping the nature and magnitude of the family labour supply (Adam 1996). El-Amin (1981) found a significant effect of family size and composition on family labour supply in Gezira Scheme. Also El-Jack (1986) found similar results.
Within the family, there is generally some division of labour, many tasks being traditionally considered as age and sex-specific. Labour is not just a homogenous input but consists of various different age and sex-groups (Upton 1987). However, the various members of the family, depending on their age, sex and health status, are not equally apt to the same types of activities, that is, there exists a division of labour (Yousif 1985). Men and women have very different lifetime labour supply behaviour, partly due to the division of labour within the family, and partly perhaps to labour market discrimination (Polachek and Stanley 1993). In the presence of returns to specialization, it is optimal for households to divide tasks among their members. If tasks require different levels of human capital e.g. strength, experience, literacy…etc, household members should be allocated to those tasks for which they have a comparative advantage (Becker 1965). Evidence from rural Pakistan supported that the intra-household allocation of tasks is conditional upon gender and family status (Fafchamps and Quisumbing 2003).

Associated with the determination of labour supply is the conversion of children-days, women-days and old person-days into man-days. The contribution made by these categories, particularly women, to labour supply is affected by certain factors. Children and old-aged people are normally described by as intermittent workers as their contribution is normally needed only at peak demand (El-Jack, 1986). The shortages of male labour during the peak production season within many households and the exorbitant cost of hiring farm hands have forced farm females to assume additional farming duties (Rahji and Falusi, 2005). Women
contribution to agricultural production in Sudan is very substantial. This contribution varies from one region to another according to socio-cultural and economic factors. In the Gezira scheme we found that, females may work as tenants, as family unpaid labour and as hired or seasonal labour (Musa, 1996). Women may be involved in cotton picking, harvesting of groundnuts and vegetables, practice sharecropping, sublet plots of land from tenants or work in their tenancies. A number of factors are related to female labour force participation; most important among these are the pattern of land distribution, the economic status of the family, ethnicity, the influence of customs and traditions, education and the presence of children (Yousif, 1985). However, according to the world Bank Report (2000), the factors related to women contribution in the labour force are that, sons of tenants are attracted to white collar jobs which may open worth chances for women; the out-migration of men and the poverty and bad economic conditions.

The participation of children in farm work is a prominent feature in almost all agricultural societies (El-Jack, 1986). A prominent feature of the African rural economies is the significant participation in agricultural production of children (Cleave, 1974). In rural Sudan, particularly in Gezira scheme, children participate sometimes in agricultural activities; even those in school participate in the evenings in farm work (El-Jack, 1986). In any household, a child’s non-leisure time is available for schooling, home production or income-earning work in the market. The way the household allocates the child’s time depends on household size and structure, the productive potential of the child and its parents
and the degree of labour substitution between the child and its parents (Grootaert and Kanbur, 1995). Bhalotra and Heady (2000) modeled labour supply for Ghana and Pakistan children. The incidence of child farm labour was found to be greater in Ghana than in Pakistan. They also found that, the household size, composition, income and farm size were among the factors that increase child work on farms. Cleave (1974) argued that, in rural Africa, although children work the same length of working day as adults, their contribution to total production is less, because of school attendance and their low efficiency levels. According to the World Bank Report (2000) in Gezira Scheme, children of tenants appear to contribute a very small percentage of the labour force engaged in agriculture. The majority of these children are indeed attending school. However among the migrant labourers, the involvement of children in labour is large. The majority of them are engaged in agriculture with their parents, mainly in cotton picking, harvesting of groundnut and vegetables.

There are important links between labour supply, fertility and composition. There is strong negative correlation between the presence of young children in the household and female labour supply whereas; male labour supply is positively correlated with the presence of young children (Browning, 1992). The number and age distribution of children have been found empirically most important for determining the participation and labour supply of married women (Hanoch, 1982). In Gezira scheme, Yousif (1985) found that, the presence of young children has a negative effect on their mothers’ work on farms. Maglad (1998) in the context of an urban labour market in Sudan found similar results.
3.9.3.4.2 Educational level:

Growth in knowledge seems to be a major factor causing the long term rise in labour productivity, real wage rates and per capita incomes in market economies (Huffman, 2001). The positive association between education and labour market outcomes is well documented. Similarly, education plays an important role in affecting non-market outcomes and input allocations (Strauss and Thomas, 1995; Huffman, 2001). Education is measured by years of school completed. This overlooks other important elements of education that may affect labour supply and demand, such as quality of education and training (Hanoch, 1982). An important factor in determining a farmer’s managerial skills is his education, which is usually measured in terms of the number of years of formal education of the household head (Kanwar, 1998). Formal schooling of household members is an asset by which the household is able to capture its maximum returns (Yang, 1997). Most of the human capital literature pertaining to developing countries focuses on the returns to education in either farm work or wage work; yet many households developing countries are engaged in several income-generating activities. Estimating a farm household’s returns to education on and off the farm will help in explaining the connection between education and the development process (Jolliffe, 2004). In rural settings where farm households engage in multiple lines of production, human capital may enhance the efficiency of individual activities and the selection of activities (Yang and Mark, 2002). Evidence from rural Pakistan showed that, households with better-educated males earn higher off-farm income and divert labour resources away from farm activities.
towards non-farm work (Fafchamps and Quisumbing, 1999). Yang (1997) with Chinese data, found that, schooling does not enhance labour productivity when carrying out routine tasks, that the contribution to farm efficiency by the most educated members is not affected by their non-farm participation, and that schooling increases labour market wage rates. He added that these empirical results give comparative advantage for the better-educated farmers to work off the farm. Yang and mark (2002), based on cross-sectional Chinese data, found that schooling and experience have significant impacts on rural household earnings from both agricultural and non-agricultural sectors.

In the context of the developing countries, few studies found a positive and significant effect of farmers’ schooling on farm work, whereas, individual’s schooling has been an important determinant of off-farm work participation (Huffman, 2001). Rosenzweig (1980) who used an Indian data to examine several labour issues, found for schooling a positive significant effect on male workers wage and no significant effect on female workers wage. He also found that schooling and experience were relatively unimportant in explaining wage rates for causal workers. With respect to off-farm work he found a negative and significant effect of schooling on both male and female workers. For a sample of Chinese farm households, Yang (1997) found that an individual’s schooling and potential labour market experience have a positive and significant effect on the off-farm wage. With data from Ghana, Jolliffe (2004) estimated returns to education in farm and off-farm work. His results showed that much of the value from increasing the educational attainment of farm households is found in its impact
on off-farm activities, including the reallocation of time away from farm work. Also increases in education levels are associated with decreases in the household’s labour supply on the farm and increases in household’s off-farm labour supply.

3.9.3.4.3 Health status:

The link between health and labour market outcomes in developing economies should be of special interest, because, there is a long tradition of theoretical models of nutrition-based efficiency wages in the development literature and that the structure of employment in lower income economies is such that work often relies more heavily on strength and endurance, and therefore, on good health. In addition, knowledge of the nature and extent of links between health and labour market outcomes is also important for policy (Strauss and Thomas, 1998).

Better health and nutrition, as related to labour productivity or better production, can increase household income and economic growth. Poor health will result in a loss of days worked or in reduced work capacity, which is likely to reduce output (Croppenstedt and Muller, 2000). The effect of health on labour supply includes several components. First, increases in an individual’s wage rate due to better health. Second, the wage gain is associated with an income effect that is weighted by hours worked, which will decrease labour supply, if non-work activities such as leisure are a normal good. Third, improved health may increase the capacity to engage in work (Schultz and Tanzel, 1997). Health status is multi-dimensional and different dimensions of health are likely to have different effects on labour markets outcomes. Thus a range of health indicators has been adopted in
empirical analysis including morbidities, anthropometrics and nutrient intakes (Strauss and Thomas, 1995).

Nutritionists have used anthropometrical data, namely, weight-for-height as an indicator of health status or strength. Conventionally, health status had been used by nutritionists and researchers in health studies to reflect morbidity experience (Aziz, 1995). However Strauss and Thomas (1995) mentioned that, morbidity data are usually based on self-reports, which are therefore, subjective and prone to reporting errors. Anthropometrical measurements in particular height and weight have been suggested as more objective indicators of health status. For households without productive assets such as land, labour force participation decisions are made by comparing the marginal rate of substitution between goods consumption and leisure to the potential market wage and choosing to work if the wage is greater. Both the market wage and the marginal rate of substitution depend on health outcomes (Strauss and Thomas, 1998). A number of studies have shown that health and food consumption directly affect productivity and wage rates in low-income environments (Strauss, 1986 and Deolalikar, 1988; Schultz and TANzel, 1997; Croppenstedt and Muller, 2000).

3.9.3.4.4 Exodus from farms:

The flow of labourers away from agriculture is an important factor affecting agricultural labour supply and productivity in this sector. Exodus from farms seems to be a problem to agricultural areas characterized by marked troughs and peaks in the demand for labour, especially in areas where cash crop production is
predominant (Cleave, 1974). Off-farm employment of farm household members is an important phenomenon throughout the world and it seems to alter on-farm labour allocation (Blekesaune et al, 1993 cited in Rahji and Falusi, 2005). In the Gezira Scheme, in situations of low economic return for tenants and high indebtedness, men migrate in search for better employment in urban centers in the country or migrate to the Arab oil producing countries. The practice of selling tenancies is currently being practiced in the scheme, though highly restricted by the scheme management. There is an increasing incidence of half tenancies, and there is absenteeism by tenants and the use of wakeel system (World Bank Report, 2000). In his multivariate analysis of the determinants of labour supply in Gezira Scheme, Yousif (1985) found that, female-headed families are more common among the landless than among the landed households due to out-migration. Also, families headed by widowed and divorced women are more prevalent among the landless than landed households. He further showed that, out-migrants are young educated males who move to the urban centers or even emigrate abroad.

3.9.3.4.5 Socio-cultural and institutional factors:

Generally, the allocation of tasks within households is not solely driven by comparative advantage consideration. Non-economic explanations of social roles also shape the intra-household division of labour (Fafchamps and Quisumbing, 2003). Agrarian relations are governed by a combination of market forces, custom and power. Social institutions and customs can affect the functioning of an economy by setting up barriers to
mobility. Thus, in certain situations, it may not be possible for a peasant to become a landlord, not only for economic reasons but also because of social restrictions. Similarly, institutions like caste could hamper movement between skilled and unskilled labour (Basu, 2003). Foster and Rosenzweig (1996) mentioned that there are three determinants of the allocation of workers among tasks:

- Differences in the productivity of workers at different tasks (comparative advantage).
- Preferences of individuals for different types of work.
- Preferences of employers for different types of workers.

According to Yousif (1985) the socio-cultural and institutional factors are important determinants of labour supply, especially female labour supply. In the context of India, Kanwar (1998) argued that, there is much evidence to show that many occupations were traditionally determined along caste lines and continue to be so, especially for women. He found a negative significant effect of caste on female labour supply. Babikir and Ahmed (1988) have shown that, there is a higher rate of family participation in cotton picking, in the Blue Nile area, among the West Africans than among the Arabs. Fafchamps and Quisumbing (2003) found that, in rural Pakistan, the intra-household division of labour is not solely driven by comparative advantage considerations, but partially determined by social norms. Yousif (1985) argued that, ethnicity is a good indicator of the influence of socio-cultural factors on labour supply.
3.9.3.4.6. Wage rates:

Expected market earnings rate affects labour supply as suggested by economic theory (Mohammed 1979). From an economist’s perspective, the most important explanatory variable in a labour supply equation is the market wage rate. But there are many problems in obtaining an adequate measure of wages, which may lead to statistical bias (Schultz 1982). For instance, Bardhan (1979) in his estimation of labour supply functions in Indian agriculture reported that, his serious problem is that of finding an appropriate wage variable. Generalization about the effect of wages on labour supply is meaningless since wages affect the labour supply of different social groups differently (Mohammed 1979). A positive relationship between aggregate supply of farm wage labour for all adults per household and the weighted average village wage has been reported by Bardhan (1979) in India. Rosenzweig (1980) found a similar result, but Papola and Misra (1980) found a negative significant response of wage rates on female labour supply of agricultural workers in India. However, Kanwar (1998) found that for landed households the wage response is positive and significant, while it is negative and significant for landless households.

While it is common to find a positive relationship between own wage and the amount of labour supplied by a worker, it is also not uncommon in crosssectional studies to find a negative relationship between an individual’s wage rate and the amount of work supplied by other members of his family (Mohammed 1979). For instance, increase in the wage rate of the husband may result in a decrease in the amount of time supplied by the wife to the market
since her marginal productivity in household activities may exceed her marginal productivity in the market (Schultz 1982).

3.9.3.4.7 The family resources:

Household labour supply is affected by the amount and quality of resources under the control of the household. An important resource in underdeveloped rural societies is land available to the household through ownership or rent (Mohammed 1979). El-Jack (1986) argued that, in the Gezira Scheme one could refer to the tenants’ property income as a possible determinant of labour supply. Bardhan (1979) found a positive association between the total supply of labour and the size of farm. El-Amin (1981) found a positive and significant effect of farm size on family labour supply in Gezira Scheme. The family resources other than land, according to El-Jack (1986) may be certain assets from which tenants may earn incomes such as shops, tractors, vehicles …etc. He simply termed these sources of income as non-farm income. He found that the availability of non-farm income discouraged the household labour supply significantly. El-Amin (1981) found a negative and significant effect of off-farm incomes on family labour supply. Gussm El-Seed (1983), also in Gezira Scheme, found that family labour supply is negatively correlated with tenants’ off-farm incomes and cash earned from livestock sales.

3.9.3.5 Empirical studies of labour supply:

In the context of farm household models, many empirical studies were found in the literature pertaining to labour supply estimation (Lau et al, 1978; Rosenzweig 1978, 1980; Barnum-

Lau, et al (1978) using data from Taiwan, estimated a set of behavioural equations, including the demand functions of leisure from which a labour supply function is derived. They found that, an increase in wage rate and the number of family workers led to an increase in labour supply, while an increase in the availability of non-agricultural commodities led to a decrease in labour supply. Rosenzweig (1978) using Indian data formulated a general equilibrium competitive market model, with emphasis on the effects of a redistribution of land holdings. He found a positive relationship between labour supply and wage rates. He also ascertained that decreases in land holding inequality and reductions in the proportion of landless households lowered labour market participation significantly. In another attempt, (1980), using a standard labour supply model and data from India, he estimated male and female labour supply functions for agricultural workers from farm and non-farm households. He found that, the net market supply responses to a wage change in landed households is greater than that in landless households, also a negative relationship between production assets and participation in the labour market and finally that the gross male wage effect on female market supply in both landless and landed households is negative and significant. Bardhan (1979) used crosssectional data for agricultural workers from rural Bengal to estimate a number of labour supply functions. He found that, the supply of labour for hiring-out is positively related to the current wage rate and negatively related to the farm size. For on farm labourers, he found
that, their supply of labour is positively related to the farm size, the number of dependents per earner and the number of working adults. For women, he found that, their supply is negatively related to the number of dependents, number of adult males and with village unemployment rate. Barnum and Squire (1979) developed a well-known model of farm household with data from Malaysia. They integrated production; consumption and labour supply behaviour in an econometric model for a semi-commercial farm with a competitive labour market. Among their results were that, an increase in the number of dependents led to an increase in the labour supply and the supply of migrant labour in relation to wage is negative and in-elastic. Evenson (1979) attempted to specify the determinants of time allocation with data from rural Philippines. Important among his result was that, there is a negative relationship between individual market time and the cultivated acreage and a negative relationship between non-wage income and the market time. Yang et al, (2004), based on data from rural China, found that input, output prices and wage rate for non-farming employment, have little effect on time allocations for farming and non-paid housework, whereas, plow land area, education levels and marital status have strong impacts on farm families’ time allocations. Kanwar (1998) with data from India, estimated on and off-farm labour supply functions for cultivated and landless households using maximum likelihood and Ordinary Least Squares methods. He found that, the wage response is positive and significant for cultivator households while it is negative and non-significant for landless households. He also found that, gross cropped area, percentage area irrigated; input
expenditure and non-land assets were significant determinants of labour supply for cultivator households. Thapa (2000), in the context of non-recursive farm household models, with data from Nepal, estimated labour supply equations. Important in his findings, was the negative income and positive wage effects, both significant, on labour supply of agricultural workers.

3.10 Demand and supply of agricultural labour in Sudan:

3.10.1 Introduction:

Agriculture in Sudan is bisectoral and characterized by an obvious dualism. Modern sector comprising irrigated and mechanized rain-fed agriculture coexists with a traditional rain-fed sector (El-Jack, 1986). Historically Sudan has witnessed a process of commercialization of labour beginning in the early part of this century with labour recruited for irrigated agricultural schemes. It also included the fairly recent emergence of the use of hired labour in large scale mechanized rain-fed agriculture along with the growth of urban wage employment. The labour markets in agriculture differ primarily according to whether they are for irrigated schemes or mechanized rain-fed cultivation. Among these differences are the variations in wage rates in the two sectors (El-Bagir et al, 1984). It has been argued that, these differences are now breaking down paving the way for the formation of national labour markets in Sudan (O’Brien, 1983).

In the mechanized sector, labour use is affected by; the resource base of different socio-economic groups, the division of labour within the household, the Seasonality of work and trends in market
and non-market labour contracts (El-Bagir et al, 1984). For the traditional sector, the evidence suggests that there are considerable variations in wage rates depending on seasonal factors and the demand situation in the labour market (Salih, 1987). In the irrigated sector, the labour market is only to some degree a local market. The degree to which it is local in the sense of reflecting purely local elements of supply, demand and resource endowments may be very small indeed (El-Bagir et al, 1984).

Views concerning the labour situation in Sudanese agriculture are of great diversity and there is a dissent on whether there is an abundant or inadequate supply of labour for agriculture. Some argued that there is sufficient labour to meet the requirements of production, while others argued that, there is a labour shortage either throughout the year or at certain times (El-Jack, 1986).

3.10.2 Studies based on labour balance approach:

The labour balance approach is an attempt made to estimate the balance between labour supply and demand at a particular point in time. Shortage of labour refers to a situation when output is restricted due to insufficient labour, whereas, labour surplus refers to a situation under which not all the available labour is utilized (El-Jack, 1986).

Among the supporters of labour shortage notions in Sudanese agriculture were; Nigam (1975); Gelal Eldin (1977); Mohammed (1977) and Mohammed (1979). Gelal Eldin (1977) argued that, in spite of the underutilization of labour, it couldn’t be claimed that there is surplus labour in the rural areas of Sudan; in fact, during the cultivation season there is an acute shortage of labour.
However, El-Jack (1986) who reviewed critically the above-mentioned studies, argued that, what is reported by Gelal Eldin couldn’t be considered as an indication of labour shortage in the sense of restricting production. He suggested the following points as limitations to the use of labour balance approach:

- The problems of accuracy of crop areas and livestock numbers.
- The problems of accuracy of unit requirements.
- The questionable validity of labour supply estimates
- The problems of accuracy of the population size estimates and of allowances for migratory flow.

Nigam (1975) reported that, one of the problems and paradoxes facing the Sudanese economy is that while there is overall abundance of labour supply in the country, organized agriculture faces shortage of labour at harvest time. The most typical case is the Gezira scheme where about 400000 persons are imported annually to pick cotton for a period of about two months. El-Jack (1986) raised the following points as drawbacks of Nigam’s study:

- Nigam excluded the nomads from the rural population, thus underestimating the available labour supply.
- Nigam did not make a field survey to determine the labour requirements for different agricultural areas, but his work was made on the basis of representative farms.
- Nigam had not made any classification of the rural population by age groups and sexes.
- Nigam used old data of 1964/1965 agricultural census and this made his calculations unreliable.
Following Nigam, Mohammed (1977) examined the situation of agricultural labour supply using data from 1955/1956 and 1973 censuses, and secondary data to work out labour requirements. El-Jack (1986) suggested the following points as drawbacks of Mohammed’s study:

- The points leveled against Nigam’s study may also be considered as shortcomings in Mohammed’s study, since they followed the same procedure.
- Mohammed had overestimated the nomadic population and in turn underestimated the agricultural population and consequently the available agricultural labour supply.
- In estimating available labour supply for agriculture, he excluded those below 15 years from the economically active population, where there is no logic to exclude them.

However, again Mohammed in another attempt, (1982), using the same procedure, recalculated the available labour supply and labour requirements for Sudan’s agriculture. He concluded that, for the country as a whole, the demand exceeds the supply in the months of August and November and Kordofan and Blue Nile areas faced severe shortage of labour in some months. Again El-Jack (1986) raised some points as weaknesses of Mohammed’s study:

- He used unacceptable adjustments and some secondary data to get the labour requirements of some crops.
- He excluded children below 10 years while a considerable portion of them undertakes agricultural work and this may underestimate the labour supply.
• Among his conclusions, he mentioned a labour shortage in Kordofan area, which is, considered one of the main sources of migrant labour for irrigated agriculture.

• He used old data of 1964/1965 agricultural census.

Then further El-Jack (1986) generally commented that, these studies, though following the same approach, they have come to different conclusions. These differing results may raise the question of how useful is the labour balance approach in revealing labour shortages or surpluses. However, he suggested the following points as measures to avoid the problems of this approach:

• More reliable estimates for unit labour requirements.

• The benefit of household survey data on availability and participation rates.

• The importance and value of village level and farm level balances in addition to national balances.

Then considering these measures, he utilized this approach in estimating labour supply and demand in Gezira scheme, season 1983/1984. He found that, there were labour deficits in seven months, which needs to be covered from local and migrant sources of labour.

Depending on what is stated by the notions of labour shortages and surpluses and using regression analysis, El-Amin (1981) and Gussm El-Seed (1983) attempted to explain these views. For instance, Al-Amin (1981) mentioned that, the labour shortage problem in Gezira Scheme is not due to labour unavailability but is rather a direct consequence of the low level of
participation of both family and hired labour in farm work especially that of family labour.

3.10.3 Studies based on production function approach:

The production function provides a measure of the technical relationship between inputs and total output value, that is, given the household’ labour allocation decision, it provides a measure of the returns to labour in particular activity (Cook, 1999).

According to this approach, it is possible from estimates of a production function, to test whether the elasticity of output with respect to labour input is significantly different from zero or not. The evidence of the existence of labour surplus is when the marginal value product is zero. This approach indicates the presence or otherwise of surplus labour, but does not measure its magnitude (El-Jack, 1986). The simplest definition of surplus labour is that labour can be transferred out of the traditional sector without reducing the volume of farm output. This definition implies the existence of some point at which the marginal product of labour becomes zero. A broader definition, which does not require that the marginal product of labour fall to zero, is that the reservation wage, that is the minimum level of compensation required to induce labour to leave the farm, is greater than zero but is substantially below the wage rate in the non-agricultural labour market (Cook, 1999). However, Rahji and Fulusi (2005) argued that this assertion, does not take into consideration the changing profile of farm households especially those who have access to non-farm employment opportunities. According to (Yang et al,
2004), scholars have suggested four different ways to measure the extent of the labour force surplus, namely:

- Measuring latent unemployment or surplus labour force from the marginal product of labour.
- Basing measures of the surplus labour force in terms of the productivity of labour, from the expected and actual working times for farmers.
- Based on expected income, from assuming a standard income level for farmers and comparing the labour force necessary to achieve that income with the actual labour force input.
- As an input measure, by assuming a standard input and comparing this with data on actual inputs.

However, according to Heady and Dillon (1961), empirical work related to the estimation of the production functions and the implications drawn out of them, involve a number of problems. The applicability of an estimated function depends on how the input and output variables are measured and defined, and in addition, the use for which the function is to be put. For labour input, it must be the actual labour input used, not the total labour used and unused during the production period. Also in practice, it is difficult to measure labour input directly. In relation to land input, the major difficulty is in measuring its quality. The problem in measuring output arises from the use of an aggregative measure of the value of output.

The productivity of agricultural labour is central to any discussion of rural development (Rahji and Falusi, 2005). In
developing countries, where labour markets are imperfect, wages are poor proxies for labour returns; so instead, labour returns can be obtained by estimating shadow wages using agricultural production function (Linde, 2001). The productivity of females has always been subsumed into that of males. Yet to understand the labour supply decisions of farm households the return to work and how they differ by gender must be considered. The new direction in family labour time allocation is to treat men and women and even children as different types of workers, each with their own shadow value of time or marginal productivity (Jacoby, 1992). Given the gender specificity of agricultural tasks in most developing countries, and the existing evidence on the heterogeneity between family and hired labour, each type of these labour inputs is specified as having different effects on agricultural output (Evenson 1978; Deolalikar and Vijverberg, 1987; Jacoby, 1993; Skoufias, 1993, 1994). In these cases, it is the shadow wage, rather than the market wage, that determines the labour supply and demand choices of the household (Strauss, 1986; Benjamin, 1992; Jacoby, 1993). For instance, Jacoby (1993) and Skoufias (1994) have used constructed shadow wages for men and women to estimate labour supply functions.

Using the production function approach and data from El-Rahad project, Ali (1976) estimated a production function of three variables to test for labour productivity. He concluded that, the marginal productivity of labour is positive and significantly different from zero. Then following the same procedure, Ali (1976) with data from the Northern region carried out the same test and concluded with the same results. However, El-Jack (1986)
critically reviewed Ali’s two studies and suggested the following points as drawbacks:

- The two studies do not take into account the fact that the response of output to input is not the same for different seasons of the year, i.e. it must differentiate between labour productivity in the slack and the peak season.
- In the measurement of the labour input, no distinction is made between family and hired labour.
- The equations were estimated from small samples and so their results cannot be generalized.

In the context of Gezira Scheme, Babikir (1998) used the same approach to test for productivity of labour, capital and farm income resources. He utilized the Cobb-Douglas form of the production function with many explanatory variables. Among his results was the positive and significant marginal productivity of labour resource in Gezira scheme.

3.10.4 The demand for agricultural labour in Sudan:

One of the theories, which predict and explain the behaviour of the labour demand, is the marginal productivity theory, which states that, a relationship does exist between the quantity of labour demanded and the price that must be paid for that labour. This theory has been criticized on the grounds that the conditions allowing for the formation of the assumption of perfect competition in the commodity market could not exist in the labour market (Polachek and Stanley, 1993).

Based on the assumption that, the marginal productivity theory has a labour market content compared to labour balance
approach, El-Gadal (1982) with data from El-Rahad project, utilized this theory to estimate cotton pickers demand functions. He used the linear and Cobb-Douglas specifications to estimate the production functions. He found that, both family and hired labour significantly explain most of output variations, and that, the value of their marginal product is higher than the wage rate, which was lower than wage rates in other surrounding areas. Then he ended up with a conclusion of labour shortage as labourers may go to areas of higher wage rates. Also, El-Amin (1981) and Babikir (1998) utilized the marginal productivity concept to assess resources productivity in Gezira Scheme. However, Gussm El-Seed (1983) quoted from Clayton (1979) that, the demand for labour as dictated by the labour price (wage rate) is to a large extent misleading. Factors like agro-ecology, biological characteristics of the crop, use of chemicals, mechanization, farm size and rotation have greater influence on crop labour inputs.

According to El-Jack (1986), the following factors may be considered as some of the determinants of labour demand:

- The cropping pattern: this influences the overall demand for labour as some crops are labour intensive while others require little labour. Also the relative importance of various agricultural operations changes with cropping pattern and the timing of these operations, sometimes lead to temporary peaks of labour demand.
- Seasonality: the demand for labour by various crops varies from one season to another. At certain times there is a peak demand for labour, in others little labour is needed.
• Use of mechanization: these are considered as substitutes of labour, so they are expected to reduce labour demand. Similar effects to those of mechanization on labour use can also be attributed to the use of herbicides and other labour-saving techniques.

• Area under cultivation: an increase in the area cultivated will normally be associated with an increase in labour use.

• The technologies made available by the green revolution such as improved seeds, chemical fertilizers and plant protection measures. The demand for labour is expected to increase with the adoption of such technologies.

In the Gezira Scheme, the contract between the tenant and the Board is central to the pattern of cultivation as well as the operation of the labour market. It has always been expected that, the tenants would provide the main labour input to the tenancy, with additional help from paid labourers at the two cultivation peaks at weeding and harvesting. The demand for the hired labour is dependent on the following factors:

• Availability of labour within the tenant household: this depends on the demographic distribution of the household, the willingness of its members to work without additional wages and the involvement of its members in other activities.

• Seasonality of agricultural operations: the sharper and thinner the seasonal peaks of labour requirement, the more are households likely to demand additional labour.

• Physical labour requirements of cultivation.
• Financial positions of the tenants.

3.10.5 The supply of agricultural labour in Sudan:

3.10.5.1 Sources of labour supply:

Labour for farm work in Gezira scheme comes from three principal sources:

• Landholding families (family labour).
• Landless families (hired labour).
• Seasonal migrant families.

The existence of a hired labour market facilitates the participation of the landless and seasonal migrant families in agricultural production. These three sources of labour are interrelated (Yousif, 1985).

According to El-Bagir et al (1984) sources of labour supply in Gezira Scheme could be classified into:

1. Tenants and their households:

These are expected to contribute the bulk of the work requirements in the farms (El-Jack, 1986). However many studies revealed that there are low levels of family labour participation to farm working (El-Amin 1981; Gussm El-Seed 1983 and Babikir 1998). El-Jack (1986) argued that, with the present cropping pattern it is not even theoretically possible for a tenant’s household to supply all the needed labour. Studies by the socio-economic and planning unit of Gezira Scheme (1994) have found that, with increasing farmer wealth, educational achievements and social aspirations, less than 20% of tenants rely on family labour and that hired labour is a dominant factor of production. El-Jack (1986)
mentioned that, the contribution of tenant households to farm work is affected by tenants’ age, their sex distribution and transference of tenancies. However, some studies revealed that the family labour contribution to farm work is very low in irrigated agriculture. For instance, El-Amin (1981) found that, they contribute about 29% of the total labour requirements. El-Jack (1986) argued that, of the average household size (7.5 persons), only about one to three persons, on average, were involved in farm work. Also, Babikir (1998) found that the tenant households contributed only about 27.9% of the total labour requirements for the major field crops in Gezira Scheme.

2. Labour from villages’ residents:

This category involves the non-tenant labour from Gezira villages. They constitute the hired labour available to perform many operations. As a tenant household’s contribution decreases and the labourers from camps are busy with their shared crops, it is probable that labourers from tenants’ villages now play a more prominent role than previously in the supply of labour (El-Jack, 1986). The development of the Gezira Scheme created a class of labourers who no longer had rights to land for their minimal subsistence purposes. For this group, the only source of income was from labouring or from other trades (El-Bagir et al, 1984).

3. Labour from camps:

These are labourers who migrated to the scheme area from other areas of the Sudan or from other African countries such as Nigeria and Chad. Motives behind their movement were the drought in their home areas as well as religious, political and
economic factors (El-Jack, 1986). The camps labourers enter the market with the advantage that their work is necessary and in demand for tasks which must be done speedily. They enter with the tenants a range of actual contracts from the straightforward individual- to individual contract for piecework to the complex sharecropping (El-Bagir et al, 1984). However, according to the World Bank Report (2000) camp peoples were estimated to be about 600000 persons living in about 1000 camps which were planned in designated areas with houses built of non-permanent materials. They are of crucial importance to tenant production and income.

4. Seasonal migrants:

These are labourers who come to the Gezira Scheme seasonally for agricultural work predominantly cotton picking. Sources of them are from the Arabs of the East Blue Nile and those of Managil area, and from Kordofan, Darfur and Kassala states, as well as from non-Sudanese sources. They come to the scheme either through recruitment by the tenants or by the Gezira Board or by their own motivation (El-Jack, 1986).

3.10.5.2. Some empirical studies of labour supply:

El-Jack (1986) suggested some possible determinants of the agricultural labour supply from the three main sources, namely tenant households, local and migrant labour. With regard to tenant households he hypothesized that, the determinants of their labour supply to be off-farm incomes, wage rates, demographic characteristics, area cultivated and climatic conditions. For the migrant labour, their labour supply determinants are transportation
cost, annual rainfall (at home) and wage rates. And for the local labour, the determinants are the same as those for tenant household labour (family labour). Then using Ordinary Least Squares method he estimated labour supply functions for cotton pickers and for family, hired and total labour supplied for agricultural activities, season 1983/1984. Among his results, for cotton pickers, was the significance of wage rate as a most important determinant of their labour supply. For other categories of labour he found that, the most significant determinants were household size, tenant age, distance from village, the availability of non-farm employment, and the expected returns from cotton and cash from dura sales. In his attempt to study the determinants of family labour supply in Gezira scheme, El-Amin (1981) found that, family size and returns from farming were positively significant in family labour supply determination, while the amount of off-farm work, availability of hired labour and sources of external funds had negative significant effects. Similar work was done by Gussm El-Seed (1983) in the context of El-Rahad Scheme. Among his results was that, wage rate was a highly significant determinant of family labour supply. Yousif (1985) with data from Gezira scheme and with stress on the demographic and socio-cultural determinants of labour supply, attempted to specify the possible determinants of male and female agricultural workers in the scheme. He found that, ethnicity, relationship to the head of household, age, out-migration, education and number of children below ten years were significant determinants of the male labour supply. Also he found that, education, relationship to the head of household, age, economic status, ethnicity and the presence of children of child caring age
were the significant determinants of female labour supply. Mohammed (1979) with data from New Halfa Scheme estimated cotton picking labour supply functions for the household members (male, female and children). He found that, family size; net income, number of children, wage rate and number of males per household had significant effects on male labour supply. For the female labour supply, net income, number of children, average number of females per household, wage rate and family size were of utmost significance. Ahmed (1986) using data from the Blue Nile Corporation Schemes estimated the family and hired labour supply of cotton pickers. He found that, wage rate, number of adult females, number of children below 15 years and ethnicity were the most significant determinants of the family labour supply, while, wage rate and yield per feddan were significant determinants of hired labour supply for cotton pickers.
CHAPTER FOUR
DISSCRIPTIVE STATISTICAL ANALYSIS

This chapter presents and discusses the descriptive analysis of the study. This analysis includes the socioeconomic characteristics of the Gezira tenants, the availability and use of the main resources, farm and off-farm incomes, labour requirements of the major field crops in the scheme, monthly and gender allocation of labour, labour supply situation in Gezira Scheme, labour returns and wages structure and formation. Then in the second part, some economic aspects related to labour markets, such as sharecropping, migration and off-farm labour are analysed.

4.1 Social characteristics of the Gezira tenants:

The social structure of the tenant and his family is regarded as an important factor that influences the tenants’ contribution to farming activities (Mohammed, 1979).

For the purpose of this study, the tenant household applies to those members of a family who live together and who are assigned a tenancy in Gezira scheme. Table (4.1) gives details of the household structure of the Gezira tenants.

Production, consumption pattern and making of decisions are partially affected by the size, age and sex distribution of the farm household family members. The adoption of innovations is often thought to be influenced by the attitudes of the household head. But in Gezira Scheme this role may be restricted by the nature of the scheme management that renders farmers very passive role in decision making (Adam, 1996).
For the interviewed tenants, the average family size is 7.6 persons, of which about 4.2 (55.3%) comprise the average number of males and 3.4 (44.7%) is the average number of females. Regarding the age structure of the tenant’s sample, the average number of children is 1.5 (19.7%), the average number of prime (productive) males per household is 2.9 (38.2%) and that of females is 2.7 (35.5%). The share of the elderly persons per household is very small comprising about 0.5 (6.5%) on average, for both sexes.

4.2 Land availability and use:

In the Gezira Scheme, the whole tenancy size ranges between 15 – 40 feddans. In the Gezira Main, the tenancy size is 20 feddans and in Managil Extension, it is 15 feddans. The basic unit is ‘hawasha’ which is four feddans in the Gezira main and three feddans in Managil Extension cultivated in rotation.

For the interviewed tenants, the total cultivable land was 1511.4 feddans. Areas under cotton, wheat, dura and groundnuts were 491.3, 194.8, 540.8 and 284.5 feddans respectively. All the interviewed tenants cultivated their cotton, wheat and dura crops directly by themselves or at least supervised their cultivation. In case of groundnut, about 55.8% of the tenants’ sample cultivated it by themselves. The remaining portion sharecropped it with hired labourers. Sharecropping is a verbal contract between a wage worker and the tenant, which is illegally practiced among the Gezira tenants. In this system, the tenant provides the seeds and pays for the land preparation and sometimes shares in the cost of
harvesting. The other partner provides all the labour required. The crops often shared are groundnut, dura and vegetables.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family size</td>
<td>7.6</td>
</tr>
<tr>
<td>Number of males</td>
<td>4.2 (55.3%)</td>
</tr>
<tr>
<td>Number of females</td>
<td>3.4 (44.7%)</td>
</tr>
<tr>
<td>Number of children</td>
<td>1.5 (19.7%)</td>
</tr>
<tr>
<td>Number of prime males</td>
<td>2.9 (38.2%)</td>
</tr>
<tr>
<td>Number of prime females</td>
<td>2.7 (35.5%)</td>
</tr>
<tr>
<td>Number of elderly male persons</td>
<td>0.3 (3.9%)</td>
</tr>
<tr>
<td>Number of elderly female persons</td>
<td>0.2 (2.6%)</td>
</tr>
<tr>
<td>Average family size for agricultural work:</td>
<td>2.4 (31.6%)</td>
</tr>
<tr>
<td>Male</td>
<td>1.1 (45.8%)</td>
</tr>
<tr>
<td>Female</td>
<td>0.8 (33.3%)</td>
</tr>
<tr>
<td>Children</td>
<td>0.5 (20.9%)</td>
</tr>
<tr>
<td>Average family size for off-farm work</td>
<td>2.0</td>
</tr>
<tr>
<td>Years of schooling</td>
<td>5.1</td>
</tr>
<tr>
<td>Average age of the tenants</td>
<td>55.1</td>
</tr>
<tr>
<td>Proportion of married tenants</td>
<td>94%</td>
</tr>
<tr>
<td>Proportion of unmarried tenants</td>
<td>6%</td>
</tr>
</tbody>
</table>

Source: Calculated from field survey, 2003/2004 season.

4.3 Capital availability, composition and use:

Generally speaking capital includes a wide diversity of items ranging from durable capital such as buildings, dams, roads and machinery to stocks of materials like seed or fertilizer, which may be used up within a single season. The flow capital consists of those items of capital that are consumed or totally used up during
the season, like cost of hired labour, machinery, cost of seeds, fertilizer, sacks and other cash operating expenses. For the purpose of this study, the average values of cash expenses on capital services including seeds, fertilizers, water charges, administration fees, chemicals and machinery services were taken to represent the working capital. They were estimated at SD 57797.6, SD 32846.5, SD 26718.5 and SD 25466.6 per feddan for cotton, wheat, dura and groundnut respectively. Regarding the sources of finance for the Gezira tenants it was mentioned in the World Bank Report (2000) that there are no formal credit institutions available to Gezira tenants other than the SGB which provides short term credit for cotton production. However, about 13% of the interviewed tenants in this study mentioned that they received short term allowances for cotton production.

4.3.1 The farm income:

By definition, the farm income includes the value of farm production less expenses in one year. The value of farm production is the total output (of plant or animal origin) multiplied by its unit price, whereas farm expenses represent all farm actual expenses. On average, the net amount of farm income for the interviewed tenants was SD 289563.5. This comprised about 56.1% of the average total household income. Table (4.2) presents the frequency distribution of the Gezira tenants according to their net farming incomes.

From the table, nearly about half of the tenants’ farm incomes range between SD 41800 and SD 229499. For about 94.0% of the interviewed tenants the net farm incomes did not
exceed SD 604899 and only about 6.0% of the tenants recorded incomes of SD 604900 and higher. This may indicate that the farmers were homogenous in terms of income level.

Table 4.2: The distribution of the Gezira tenants according to their net farming incomes:

<table>
<thead>
<tr>
<th>Range (S.D.)</th>
<th>Frequency</th>
<th>Percentages</th>
</tr>
</thead>
<tbody>
<tr>
<td>41800 – 229499</td>
<td>70</td>
<td>46.7</td>
</tr>
<tr>
<td>229500 – 417199</td>
<td>51</td>
<td>34.0</td>
</tr>
<tr>
<td>417200 – 604899</td>
<td>20</td>
<td>13.3</td>
</tr>
<tr>
<td>604900 – 792599</td>
<td>6</td>
<td>4.0</td>
</tr>
<tr>
<td>792600 – 980299</td>
<td>1</td>
<td>0.7</td>
</tr>
<tr>
<td>980300 – 1168000</td>
<td>2</td>
<td>1.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>150</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

*Source: Calculated from field survey, 2003/2004 season.*

4.3.2 The off-farm income:

This part of income may be obtained from many sources, such as trading, other secondary jobs, working in the scheme, savings, remittances, gifts and social transfers. Off-farm jobs have two important effects for households. First, it provides more liquidity, which allows for having more working capital in the short term and more investments in the long run. Second, it helps to diversify income and to have more stable income when the agricultural sector faces problems (Waldemar, 2004). Many studies have shown the significant effect of off-farm income on the output of different agricultural crops in the developing countries (examples: Reardom, et al, 1998, Ellis, 1998 and Schwarze, 2004).
For the interviewed sample, on average, the off-farm income was estimated at SD 230799.5. Table (4.3) presents the frequency distribution of the Gezira tenants according to their off-farm incomes. About 37.3% of the interviewed tenants have off-farm incomes not more than SD 14999. Only one tenant recorded a relatively high off-farm income level of SD 1050000. On average, the off-farm income of the sampled tenants was estimated at SD 222966.7, which was about 43.9% of the average household total income.

**Table 4.3:** The distribution of the Gezira tenants according to their off-farm incomes:

<table>
<thead>
<tr>
<th>Range (S.D.)</th>
<th>Frequency</th>
<th>Percentages</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 14999</td>
<td>56</td>
<td>37.3</td>
</tr>
<tr>
<td>150000 – 299999</td>
<td>38</td>
<td>25.3</td>
</tr>
<tr>
<td>300000 – 449999</td>
<td>39</td>
<td>26.0</td>
</tr>
<tr>
<td>450000 – 599999</td>
<td>7</td>
<td>4.7</td>
</tr>
<tr>
<td>600000 – 749999</td>
<td>7</td>
<td>4.7</td>
</tr>
<tr>
<td>750000 – 899999</td>
<td>2</td>
<td>1.3</td>
</tr>
<tr>
<td>900000 – 1050000</td>
<td>1</td>
<td>0.7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>150</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>


### 4.3.3 The total tenant income:

Total household income of a farm household mainly comes from farm and off-farm incomes. Table (4.4) shows the distribution of the Gezira tenants according to their total incomes.
Nearly about 70.6% of the tenants having incomes not more than SD 614124, and only one tenant had relatively a higher income level of SD 1568000. On average, the household total income was estimated as SD 511106.0.

**Table 4.4:** The distribution of the Gezira tenants according to their total incomes:

<table>
<thead>
<tr>
<th>Range</th>
<th>Frequency</th>
<th>Percentages</th>
</tr>
</thead>
<tbody>
<tr>
<td>41800 – 232574</td>
<td>24</td>
<td>16.0</td>
</tr>
<tr>
<td>232575 – 423349</td>
<td>32</td>
<td>21.3</td>
</tr>
<tr>
<td>423350 – 614124</td>
<td>50</td>
<td>33.3</td>
</tr>
<tr>
<td>614125 – 804899</td>
<td>25</td>
<td>16.7</td>
</tr>
<tr>
<td>804900 – 995674</td>
<td>12</td>
<td>8.0</td>
</tr>
<tr>
<td>995675 – 1186449</td>
<td>4</td>
<td>2.7</td>
</tr>
<tr>
<td>1186450 – 1377224</td>
<td>2</td>
<td>1.3</td>
</tr>
<tr>
<td>1377225 - 1568000</td>
<td>1</td>
<td>0.7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>150</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>


**4.4 Labour availability and use:**

For the purpose of this study, the standard man-day was taken as a measurement for labour input, ignoring differences in labour quality. The standard man-day is defined as the effort extended by a healthy adult in the age of 15 – 64 years in a working day of eight hours. A one-day labour input was assumed to be 0.75 standard man-day for women and 0.5 for children and old persons (El-Jack, 1986; Babikir, 1998).
Table (4.1) shows in percentages the differentiation of the average tenant family size into either work on farms, off farms or engaged in other activities such as schooling or home work. Excluding the members of the family unavailable for participation in farming activities, an average of 2.4 man-days (31.6%) persons is estimated as available family size for field work, of which, 32%, 23% and 5% are males, females and children respectively. (Table 4.1). Assuming 20 days of fieldwork per month (Babikir, 1998), the total potential family labour supply was 576.0 man-day equivalent for the whole agricultural season. It is observed that from these estimations that, the size and composition of the tenant’s families are very important factors in shaping the nature and magnitude of family labour supply.

4.4.1 Labour requirements of the major field crops in Gezira Scheme:

Generally speaking, regarding the labour demand by the major field crops in Gezira Scheme, most of the agricultural operations for cotton, dura and groundnut are done manually, except for land preparation and threshing of dura harvest. The wheat crop is more or less a fully mechanized crop. It requires manual labour for only some light operations such as irrigation, mesih and breaking down of field channels before harvesting.

Table (4.5) presents the labour requirements for cotton, wheat, dura and groundnut on per feddan basis. Cotton is the most labour demanding crop utilizing about 63.5 man-days per feddan, of which 16.7 and 46.8 man-days per feddan were recorded as family and hired labour respectively. Groundnut required about
44.5 man-days per feddan, itemized into 10.9 man-days as family labour and 33.6 man-days of hired labour. Dura moderately utilized about 25.4 man-days per feddan, 7.8 man-days as family labour and 17.6 man-days per feddan as hired labour. Wheat, the least labour demanding crop, required about 8.9 man-days per feddan, 5.1 and 3.8 man-days per feddan as family and hired labour respectively. The farmer family is assumed to be the main source of labour supply for various farm operations. Hired labour if needed, is used in cases of seasonal bottlenecks. It was noticed that family labour contribution often increases in the light agricultural operations while there is much reliance on hired labour to perform the tedious cultivation practices. As it can be seen from the table, family labour provided only about 28.5% of the total labour used for the major field crops. However, it was realized by Barnet and Abdelkarim (1991) that the household cycle, the age structure of the individual household, and of the aggregate of the households in the irrigated areas are major factors in the demand for non-household labour. Even household labour is not always free to the household head. The larger portion of the labour requirements (71.5%) was provided by hired labour. Taking the crops individually, the contribution of family labour in case of groundnut was found to be the lowest compared to the other crops. This may be due to the sharecropping practice in which the partner performs all the labour efforts on behalf of the tenant. Wheat recorded the highest family labour contribution, since its manual operations were light jobs that can easily be performed by family labour. Many studies in Gezira scheme mentioned this low family labour participation in farm work (examples; El-Amin, 1981;
Gussm El-Seed, 1983; Adam, 1996; Babikir, 1998). In the World Bank Report (2000), it was mentioned that most of the contribution of family labour is in watering of cotton and wheat. Hired labourers who sharecropped sorghum, groundnut and vegetables with the tenants, are responsible for almost all the operations in agriculture. However, Gussm El-Seed (1983) reported that the phenomenon of low family labour participation in farming seems to be a characteristic feature of large scale irrigated schemes.

Table 4.5: The labour requirements of the major field crops in Gezira scheme (Mandays/feddan):

<table>
<thead>
<tr>
<th>Crop</th>
<th>Family labour</th>
<th>Hired labour</th>
<th>Total labour</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>%</td>
<td>Average</td>
</tr>
<tr>
<td>Cotton</td>
<td>16.7</td>
<td>26.3</td>
<td>46.8</td>
</tr>
<tr>
<td>Wheat</td>
<td>5.1</td>
<td>57.3</td>
<td>3.8</td>
</tr>
<tr>
<td>Sorghum</td>
<td>7.8</td>
<td>30.7</td>
<td>17.6</td>
</tr>
<tr>
<td>Groundnut</td>
<td>10.9</td>
<td>24.5</td>
<td>33.6</td>
</tr>
<tr>
<td>Total</td>
<td>40.5</td>
<td>28.5</td>
<td>101.8</td>
</tr>
</tbody>
</table>


Expressed on cotton basis, groundnut required about 70.1% of the labour used by a feddan of cotton. Dura and wheat required 40% and 14% respectively. The labour requirements of cotton, wheat, dura and groundnut, were found to represent about 44.6%, 6.3%, 17.8% and 31.3% of the total labour requirements of the four crops respectively. Also wheat, dura and groundnut taken
together represented about 55.4% of the total labour requirements of the four crops. This may reflect the fact that cotton is a labour intensive crop.

The Planning and Socio-economic Research Unit of the Gezira Scheme (2004) estimated the labour requirements of cotton, wheat, dura and groundnut as 63.2, 9.7, 33.2 and 44.5 man-days per feddan for these crops respectively. Also Babikir (1998) estimated the labour requirements to be 64.3, 9.5, 28.2 and 43.1 man-days per feddan for cotton, wheat, dura and groundnut respectively.

4.4.2 Labour requirements by operation:

4.4.2.1 Cotton:

Table (4.6) presents the breakdown of the total labour requirement of the cotton crop into family and hired labour by operation. Out of the 63.5 man-days required by cotton, the picking operation alone used about 36.6%, followed by the weeding operation (20.7%). The three major harvest operations, picking, packing and stalk pulling utilized about 50% of cotton total labour demand per feddan.

The highest contribution of family labour was observed in watering operation (21.2%), while that of hired labour was in the picking operation (44.2%). The family labour’s share in cotton production was estimated as 26.3% of the total labour requirement, whereas, the remaining 73.7% was supplied by hired labour. This low level of family labour participation may be explained by the intensity of labour requirement during harvest, which cannot be supplied by family labour.
Table 4.6: The labour requirement of cotton by operation (Mandays/feddan):

<table>
<thead>
<tr>
<th>Operation</th>
<th>Family labour</th>
<th>Hired labour</th>
<th>Total labour</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>%</td>
<td>Average</td>
</tr>
<tr>
<td>Mesih</td>
<td>0.7</td>
<td>4.2</td>
<td>0.8</td>
</tr>
<tr>
<td>Sowing</td>
<td>2.2</td>
<td>15.6</td>
<td>2.5</td>
</tr>
<tr>
<td>Resowing</td>
<td>0.8</td>
<td>4.8</td>
<td>0.6</td>
</tr>
<tr>
<td>Watering</td>
<td>3.6</td>
<td>21.2</td>
<td>2.8</td>
</tr>
<tr>
<td>Channels cleaning</td>
<td>0.8</td>
<td>4.8</td>
<td>0.9</td>
</tr>
<tr>
<td>Thinning</td>
<td>1.3</td>
<td>7.8</td>
<td>1.5</td>
</tr>
<tr>
<td>Weeding</td>
<td>3.2</td>
<td>19.2</td>
<td>10.0</td>
</tr>
<tr>
<td>Picking</td>
<td>2.6</td>
<td>13.6</td>
<td>20.7</td>
</tr>
<tr>
<td>Packing</td>
<td>0.5</td>
<td>2.9</td>
<td>1.9</td>
</tr>
<tr>
<td>Stalk pulling</td>
<td>1.0</td>
<td>5.9</td>
<td>5.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>16.7</strong></td>
<td>100</td>
<td><strong>46.8</strong></td>
</tr>
</tbody>
</table>

Source: Calculated from field survey, 2003/2004 season.

4.4.2.2. Wheat:

Table (4.7) presents the labour requirements by operation for wheat crop, for which, the only manual operations are raising of field channels, fertilizer application, watering, cleaning of channels, weeding and breaking of field channels. The table shows that watering and breaking of field channels are the most labour demanding operations, requiring about 34.8% and 30.4% of the total labour per feddan for wheat. The family and hired labour were found to contribute respectively 57.3% and 42.7% of the total labour for wheat production. The highest share of the family labour may be due to that wheat operations require light effort that can be performed by the family members. As shown in the table,
the contribution of family labour is high in the watering operation (34.8%) and that of hired labour is high in breaking of field channels operation (30.4%).

Table 4.7: The labour requirements of wheat crop by operation (mandays / feddan):

<table>
<thead>
<tr>
<th>Operation</th>
<th>Family labour</th>
<th>Hired labour</th>
<th>Total labour</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average (%  )</td>
<td>Average (%)</td>
<td>Average (%)</td>
</tr>
<tr>
<td>Raising of channels</td>
<td>0.4</td>
<td>0.5</td>
<td>0.9</td>
</tr>
<tr>
<td>Fertilizer application</td>
<td>0.4</td>
<td>0.3</td>
<td>0.7</td>
</tr>
<tr>
<td>Watering</td>
<td>2.1</td>
<td>1.0</td>
<td>3.1</td>
</tr>
<tr>
<td>Channels cleaning</td>
<td>0.5</td>
<td>0.4</td>
<td>0.9</td>
</tr>
<tr>
<td>Weeding</td>
<td>0.5</td>
<td>0.1</td>
<td>0.6</td>
</tr>
<tr>
<td>Channels breaking</td>
<td>1.2</td>
<td>1.5</td>
<td>2.7</td>
</tr>
<tr>
<td>Total</td>
<td>5.1</td>
<td>3.8</td>
<td>8.9</td>
</tr>
</tbody>
</table>

Source: Calculated from field survey, 2003/2004 season.

4.4.2.3 Sorghum:

Mostly all sorghum operations are done manually with the exception of grains’ threshing and packing where stationery harvesters are commonly used in Gezira Scheme.

Table (4.8) shows the labour requirement by operation for sorghum cultivation in the scheme. Grains’ cutting and collection required the highest demand for labour (35.1%), followed by weeding (26%). Family labour participates more in weeding (23.1%), while hired labour on grains’ cutting and collection. Family and hired labour as percent of the total labour was estimated at 30.7% and 69.3% respectively. This higher share of hired labour may be due to the attitude of Gezira tenants for hiring
labour to do the tedious operations during the peak periods. El-Amin (1981) reported that family labour participation often increases in the light agricultural operations with much reliance on hired labour to perform the tedious cultivation practices.

Table 4.8: The labour requirements of sorghum crop by operation (mandays /feddan):

<table>
<thead>
<tr>
<th>Operation</th>
<th>Family labour</th>
<th>Hired labour</th>
<th>Total labour</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>%</td>
<td>Average</td>
</tr>
<tr>
<td>Raising of field channels</td>
<td>0.4</td>
<td>5.1</td>
<td>0.5</td>
</tr>
<tr>
<td>Sowing</td>
<td>1.3</td>
<td>16.7</td>
<td>0.5</td>
</tr>
<tr>
<td>Resowing</td>
<td>0.4</td>
<td>5.1</td>
<td>0.3</td>
</tr>
<tr>
<td>Watering</td>
<td>1.1</td>
<td>14.1</td>
<td>0.5</td>
</tr>
<tr>
<td>Channels cleaning</td>
<td>0.5</td>
<td>6.4</td>
<td>0.5</td>
</tr>
<tr>
<td>Thinning</td>
<td>0.4</td>
<td>5.1</td>
<td>1.0</td>
</tr>
<tr>
<td>Fertilizer application</td>
<td>0.5</td>
<td>6.4</td>
<td>0.3</td>
</tr>
<tr>
<td>Weeding</td>
<td>1.8</td>
<td>23.1</td>
<td>4.8</td>
</tr>
<tr>
<td>Grains’cutting and collection</td>
<td>1.4</td>
<td>18</td>
<td>7.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>7.8</strong></td>
<td><strong>100</strong></td>
<td><strong>17.6</strong></td>
</tr>
</tbody>
</table>

Source: Calculated from field survey, 2003/2004 season.

4.4.2.4 Groundnut:
Mostly all the operations of groundnut production in Gezira scheme are done manually. Table (4.9) shows the labour requirements of this crop by operation. Out of the total groundnut labour demand per feddan, the harvesting operations alone consume about 57.1%. This may be due to that, the manual harvesting of groundnut is a very tedious and time-consuming operation. Also the weeding operation needs more attention and
time that it utilized about 21.4% of the total labour demand per feddan.

With regard to the use of family and hired labour, they were found to represent respectively 24.5% and 75.5% of the total labour used for groundnut production. This high contribution of hired labour may be attributed to the nature of the production of this crop where almost 50% of the tenants in the sample sharecropped it with hired labour. Sharecropping is a verbal contract between a wageworker and the tenant, which is illegally practiced among the Gezira tenants. The crops often shared are groundnut, dura and vegetables (Babikir, 1998).

Table 4.9: The labour requirements of groundnut crop by operation (mandays/feddan):

<table>
<thead>
<tr>
<th>Operation</th>
<th>Family labour</th>
<th>Hired labour</th>
<th>Total labour</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>%</td>
<td>Average</td>
</tr>
<tr>
<td>Raising of field</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>channels</td>
<td>0.6</td>
<td>5.5</td>
<td>0.8</td>
</tr>
<tr>
<td>Sowing</td>
<td>1.6</td>
<td>14.8</td>
<td>1.7</td>
</tr>
<tr>
<td>Watering</td>
<td>1.3</td>
<td>11.9</td>
<td>1.8</td>
</tr>
<tr>
<td>Channels cleaning</td>
<td>0.7</td>
<td>6.4</td>
<td>1.1</td>
</tr>
<tr>
<td>Weeding</td>
<td>2.0</td>
<td>18.3</td>
<td>7.5</td>
</tr>
<tr>
<td>Pulling and collection</td>
<td>1.7</td>
<td>15.6</td>
<td>8.9</td>
</tr>
<tr>
<td>Threshing and packing</td>
<td>3.0</td>
<td>27.5</td>
<td>11.8</td>
</tr>
<tr>
<td>Total</td>
<td>10.9</td>
<td>100</td>
<td>33.6</td>
</tr>
</tbody>
</table>

Source: Calculated from field survey, 2003/2004 season.

4.4.3 Monthly allocation of labour:

As shown in table (4.10), the cotton crop requires labour all year around, but for other crops usually there are no cultural activities for about four months in the season, for wheat and
groundnut, and five months in case of dura. The peak requirement for cotton is in December and January, where the harvesting operations are taking place. For wheat, this peak is in March, in September for dura, and in December for groundnut. Considering the total requirement of the four crops each month, two peaks of labour demand occurred. The first one during July, August and September (34.3% of the total) and the second one during November, December and January (41% of the total). During these two peaks the total labour demand comprises about 75.3% of the total labour requirements per feddan for the four crops taken together. During these peak periods the tenants need to do the sowing, weeding and harvesting operations. This may reflect the seasonality in labour demand in agricultural production and the necessity of labour hiring. Adam (1996) found that the demand for labour generally, begins to rise with the start of the planting activities i.e. June. This demand reached its peak during weeding of cotton, groundnut and sorghum i.e. July-August. An additional bottleneck for labour demand emerges at the time of harvest of sorghum, groundnut and cotton. It could be concluded that these results imply that, in the planned cropping patterns, it is not possible for a family household alone to supply the labour needed for cultivating these crops and as such it has to be supported by hired labour in order to meet the crops labour demand.
Table 4.10: Monthly allocation of labour for the production of the major field crops in Gezira Scheme (mandays / feddan):

<table>
<thead>
<tr>
<th>Month</th>
<th>Cotton Average</th>
<th>%</th>
<th>Wheat Average</th>
<th>%</th>
<th>Dura Average</th>
<th>%</th>
<th>Groundnut Average</th>
<th>%</th>
<th>Total Average</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>12.4</td>
<td>19.5</td>
<td>1.2</td>
<td>13.5</td>
<td>-</td>
<td>-</td>
<td>13.6</td>
<td>9.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>February</td>
<td>4.3</td>
<td>6.9</td>
<td>0.7</td>
<td>7.9</td>
<td>-</td>
<td>-</td>
<td>5.0</td>
<td>3.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>March</td>
<td>6.3</td>
<td>9.9</td>
<td>2.1</td>
<td>23.6</td>
<td>-</td>
<td>-</td>
<td>8.4</td>
<td>5.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>April</td>
<td>3.2</td>
<td>5.1</td>
<td>0.9</td>
<td>10</td>
<td>-</td>
<td>-</td>
<td>4.1</td>
<td>2.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>May</td>
<td>2.0</td>
<td>3.1</td>
<td>0.7</td>
<td>7.9</td>
<td>-</td>
<td>-</td>
<td>0.8</td>
<td>1.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>June</td>
<td>0.6</td>
<td>0.9</td>
<td>-</td>
<td>-</td>
<td>1.2</td>
<td>4.7</td>
<td>2.8</td>
<td>6.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>July</td>
<td>3.4</td>
<td>5.4</td>
<td>-</td>
<td>-</td>
<td>2.9</td>
<td>11.4</td>
<td>6.7</td>
<td>15.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>August</td>
<td>6.3</td>
<td>9.9</td>
<td>-</td>
<td>-</td>
<td>5.4</td>
<td>21.3</td>
<td>10.0</td>
<td>22.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>September</td>
<td>5.3</td>
<td>8.3</td>
<td>-</td>
<td>-</td>
<td>6.8</td>
<td>26.8</td>
<td>2.1</td>
<td>4.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>October</td>
<td>5.9</td>
<td>9.3</td>
<td>1.3</td>
<td>14.6</td>
<td>1.1</td>
<td>4.3</td>
<td>1.3</td>
<td>2.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>November</td>
<td>4.0</td>
<td>6.3</td>
<td>1.3</td>
<td>14.6</td>
<td>3.1</td>
<td>12.2</td>
<td>7.9</td>
<td>17.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>December</td>
<td>9.8</td>
<td>15.4</td>
<td>0.7</td>
<td>7.9</td>
<td>4.9</td>
<td>19.3</td>
<td>12.9</td>
<td>28.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>63.5</td>
<td>100</td>
<td>8.9</td>
<td>100</td>
<td>25.4</td>
<td>100</td>
<td>44.5</td>
<td>100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Calculated from field survey, 2003/2004 season.
4.4.4 Gender allocation of labour:

Table (4.11) shows the allocation of labour by gender on per feddan basis. The table shows that for the production of the four crops, women contribution is the highest, (67.8%), compared to that of men, (42.2%), and children, (10.2%). Taking the crops individually, they contribute more on cotton and groundnut production. This is due to their higher share in harvesting of those two crops. This could be compared to what is reported by El-Bagir et al (1984) that women make a notable contribution to all crops, but in particular to cotton and groundnut, where they are involved in all the major operations. Generally Yousif (1985) reported that an interesting aspect in the rural economy in the Gezira Scheme is that a considerable proportion of women are in the labour force. He added that this could be attributed to that the scheme provides substantial employment opportunities that are rarely available elsewhere in the Sudan. Men contribute more on wheat and sorghum production due to their higher share in watering and breaking of field channels for wheat and harvesting of sorghum. Regarding children, their contribution is estimated at about 10.2% which may be low compared to adult male and females. However, according to the World Bank Report (2000) children constitute a very small percent of the labour force engaged in agriculture, estimated to be less than 10%. The majority of children however are indeed attending school and participate in farm work after school session.
Table 4.11: Gender allocation of labour for the production of the major field crops in Gezira scheme (mandays / feddan):

<table>
<thead>
<tr>
<th>Crop</th>
<th>Male labour</th>
<th>Female labour</th>
<th>Child labour</th>
<th>Total labour</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>% Average</td>
<td>Average</td>
<td>% Average</td>
</tr>
<tr>
<td>Cotton</td>
<td>23.9</td>
<td>37.6</td>
<td>33.2</td>
<td>6.4</td>
</tr>
<tr>
<td>Wheat</td>
<td>6.9</td>
<td>77.5</td>
<td>1.4</td>
<td>0.6</td>
</tr>
<tr>
<td>Sorghum</td>
<td>12.6</td>
<td>49.6</td>
<td>9.7</td>
<td>3.1</td>
</tr>
<tr>
<td>Groundnut</td>
<td>16.6</td>
<td>37.3</td>
<td>23.5</td>
<td>4.4</td>
</tr>
<tr>
<td>Total</td>
<td>60</td>
<td>42.2</td>
<td>67.8</td>
<td>14.5</td>
</tr>
</tbody>
</table>

Source: Calculated from field survey, 2003/2004 season.

4.4.5 Socio-economic characteristics of landless agricultural labour in Gezira Scheme:

The average age of the sampled labourers was 45.4 and the average family size was 7.5 persons. Regarding their sources, 33.3% of them were seasonal labour, 35% were local labour and 31.7% were from the camps. The seasonal labour reported that, they usually participate in the picking of cotton, the local labour in weeding, sowing, thinning and picking, while the labour from camps participate in sowing, thinning, weeding and harvesting of sorghum and groundnut. The labourers, especially the labour from camps, mentioned that they always enter in sharecropping of some crops with the tenants, such as dura, groundnut and vegetables. About 48.3% of the labourers reported that the tenants gave them shelter as in kind wage, 26.7% of them given food and shelter, 13.3% given only food and 11.7% given no incentives. The seasonal and local labourers were usually from Arabian tribes, whereas, those from camps were from the West African tribes who
migrated earlier with the development of the Gezira Scheme and now they live in areas around the tenancies in a very complicated condition. As reported by the World Bank Mission to the scheme (2000) in Gezira Scheme a symbiotic and at times conflictual, relationship exists between various ethnic and social groups, largely consisting of the tenant farmers and the labourers who mainly originated from outside the Gezira area, either from Western Sudan or from West Africa.

4.4.6 Labour supply situation in Gezira Scheme:

Table (4.12) presents the amounts of labour supplied for the production of the major field crops in Gezira Scheme. Tenants’ households supplied about 47.7% of the total labour supply for the four crops and the rest was supplied by hired labour (52.3%). Out of this total, on average, the total labour supply of cotton was the highest (30.8%), compared to other crops. For wheat, cotton and sorghum the supply of family labour was 77.0%, 46.1% and 45.7% respectively, while it was low in case of groundnut (38.6%). This may be due to the sharecropping practices. On the other hand, the hired labour employed per tenancy in case of groundnut was highest compared to the other crops (61.4%). Regarding the supply situation in Gezira Scheme, it was estimated that, on average, the tenant and his family provide less than 20% of the labour, with the rest being covered by hired labour. There has also been a reported steady decline in seasonal labour supply resulting in shortage of agricultural labour (World Bank Report, 2000). For many years, it has been clear that even if tenant households worked to their
fullest capacity, they would still require additional labour, at least during the peak seasons (Barnet and Abdelkarim, 1991).

Table 4.12: The family and hired labour supply per tenancy for the production of the major field crops in Gezira scheme:

<table>
<thead>
<tr>
<th>Crop</th>
<th>Family labour</th>
<th>Hired labour</th>
<th>Total labour</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>%</td>
<td>Average</td>
</tr>
<tr>
<td>Cotton</td>
<td>116.9</td>
<td>46.1</td>
<td>136.9</td>
</tr>
<tr>
<td>Wheat</td>
<td>79.8</td>
<td>77.0</td>
<td>23.9</td>
</tr>
<tr>
<td>Sorghum</td>
<td>105.4</td>
<td>45.7</td>
<td>125.1</td>
</tr>
<tr>
<td>Groundnut</td>
<td>91.5</td>
<td>38.6</td>
<td>145.6</td>
</tr>
<tr>
<td>Total</td>
<td>393.6</td>
<td>47.7</td>
<td>431.5</td>
</tr>
</tbody>
</table>

Source: Calculated from field survey, 2003/2004 season.

4.4.7 Average productivity and returns to labour in Gezira Scheme:

Table (4.13) presents the intensity of family labour participation relative to that of hired labour and reflects the average productivity of labour in kilograms per one man-day. As shown in the table, the hired/family labour ratio was higher in case of groundnut compared to other crops, implying the lowest participation rate of the family labour in groundnut production. The lowest ratio was that in case of wheat crop, where the family members provided more than half of its labour demand. Similar results were obtained by Adam (1996) and Babikir (1998). In table (4.13), also average productivity of labour is shown as 9.9 Kg, 82.3 Kg, 27.6 Kg and 10.6 Kg per man-day for cotton, wheat, dura and groundnut respectively. The average labour productivity in
case of wheat was the highest whereas that of cotton was the lowest compared to the other crops. This may be due to the differences in yields between crops and the differences in crop’s labour demands. Similar results were obtained by Babikir (1998).

Table (4.13): Hired/family labour ratio, average productivity and productivity per manday for the major field crops in Gezira Scheme:

<table>
<thead>
<tr>
<th>Crop</th>
<th>Family labour/m.d./fed.</th>
<th>Hired labour/m.d./fed.</th>
<th>Total labour/m.d./fed.</th>
<th>Hired/family ratio</th>
<th>Yield (Kg/fed.)</th>
<th>Productivity (Kg/m.d.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton</td>
<td>16.7</td>
<td>46.8</td>
<td>63.5</td>
<td>2.8</td>
<td>630.5</td>
<td>9.9</td>
</tr>
<tr>
<td>Wheat</td>
<td>5.1</td>
<td>3.8</td>
<td>8.9</td>
<td>0.7</td>
<td>732.3</td>
<td>82.3</td>
</tr>
<tr>
<td>Sorghum</td>
<td>7.8</td>
<td>17.6</td>
<td>25.4</td>
<td>2.3</td>
<td>701.0</td>
<td>27.6</td>
</tr>
<tr>
<td>Groundnut</td>
<td>10.9</td>
<td>33.6</td>
<td>44.5</td>
<td>3.1</td>
<td>472.1</td>
<td>10.6</td>
</tr>
</tbody>
</table>

Source: Calculated from field survey, 2003/2004 season.

Table 4.14: Production levels in terms of labour requirements for the major field crops in Gezira Scheme:

<table>
<thead>
<tr>
<th>Crop</th>
<th>Family labour/kg</th>
<th>Hired labour/kg</th>
<th>Total labour/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>%</td>
<td>Average</td>
</tr>
<tr>
<td>Cotton</td>
<td>0.031</td>
<td>26.3</td>
<td>0.087</td>
</tr>
<tr>
<td>Wheat</td>
<td>0.008</td>
<td>61.5</td>
<td>0.005</td>
</tr>
<tr>
<td>Dura</td>
<td>0.012</td>
<td>30.8</td>
<td>0.027</td>
</tr>
<tr>
<td>Groundnut</td>
<td>0.021</td>
<td>19.4</td>
<td>0.087</td>
</tr>
<tr>
<td>Total</td>
<td>0.072</td>
<td>25.9</td>
<td>0.206</td>
</tr>
</tbody>
</table>

Source: Calculated from field survey, 2003/2004 season.

In order to compare the competitiveness of the crops grown, their returns to land and labour on per feddan basis were derived using financial analysis. The gross margin measures the difference between the average gross return and the average total cost of production for the crop in question. Results of these calculations
are presented in table (4.15). The total value product of each crop is calculated by multiplying the average yield by price per unit of production (SD/kilograms). From this total value product the average total costs for each crop were deducted to get the net returns. At the levels of the prevailing gross margins to the tenant farmer, wheat compares unfavorably with the other crops. Cotton gives the highest returns to all factors and dura is better than groundnut. Regarding this situation, it seems as if, the tenants will shift resources whenever possible, away from wheat and apply them to other crops. However, tenants in Gezira Scheme are not free to select their enterprises; they are obliged to follow the crop rotation prescribed by the scheme management. As shown in the table, cotton gives the highest net returns, followed by sorghum, groundnut and wheat. The net returns to the total labour are estimated, on average, as 713.0, 692.9, 583.8 and 367.5 SD/man-day for cotton, sorghum, wheat and groundnut respectively. The highest net returns to the total labour are obtained in case of the cotton crop. However, for the family and hired categories of labour, the highest net returns are from cotton and wheat respectively. The differences in net returns between crops are because of the differences in crop labour requirements, price per unit and average cost per unit area.
Table 4.15: Estimated economic returns, on average, to labour input per feddan in Gezira Scheme:

<table>
<thead>
<tr>
<th>Item</th>
<th>Cotton</th>
<th>Wheat</th>
<th>Sorghum</th>
<th>Groundnut</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross returns (SD/fed.)</td>
<td>100006.4</td>
<td>41858.3</td>
<td>44294.8</td>
<td>43142.3</td>
</tr>
<tr>
<td>Total variable costs (SD/fed.)</td>
<td>54728.6</td>
<td>36662.8</td>
<td>26695.1</td>
<td>26407.0</td>
</tr>
<tr>
<td>Net returns (SD/fed.)</td>
<td>45277.8</td>
<td>5195.5</td>
<td>17599.7</td>
<td>16354.6</td>
</tr>
<tr>
<td>Total labour inputs (m.d./fed.)</td>
<td>63.5</td>
<td>8.9</td>
<td>25.4</td>
<td>44.5</td>
</tr>
<tr>
<td>Net return/man-day (SD)</td>
<td>713.0</td>
<td>583.8</td>
<td>692.9</td>
<td>367.5</td>
</tr>
<tr>
<td>Family labour input (m.d./fed.)</td>
<td>16.7</td>
<td>5.1</td>
<td>7.8</td>
<td>10.9</td>
</tr>
<tr>
<td>Net return/man-day (SD)</td>
<td>2711.2</td>
<td>1018.7</td>
<td>2256.4</td>
<td>1500.4</td>
</tr>
<tr>
<td>Hired labour input (m.d./fed)</td>
<td>46.8</td>
<td>3.8</td>
<td>17.6</td>
<td>33.6</td>
</tr>
<tr>
<td>Net return/man-day (SD)</td>
<td>967.5</td>
<td>1367.2</td>
<td>999.9</td>
<td>486.7</td>
</tr>
</tbody>
</table>

Source: Calculated from field survey 2003/2004 season.

4.4.8 Wage structure and wage rates in Gezira Scheme:

4.4.8.1 Wage rates on piece rate basis:

As reported by El-Bagir et al. (1984) in their study of the labour markets in Gezira Scheme, there is a range of actual contracts from the straightforward individual-to-individual contract for piecework to the complex sharecropping plus cash arrangement. Agricultural wages in Gezira Scheme may either take a form of piece rates or daily rates. According to El-Jack (1986) these piece rates are linked to the intensity of the specific agricultural operation, i.e. the number of days or hours needed to perform an agricultural operation per unit area. Also these piece rates are influenced by the supply and demand situations. For the interviewed tenants, about 65% of them mentioned that they did their farm operations usually by piece rate arrangements. The remaining part preferred the per day basis of arrangements. Almost
all the interviewed seasonal workers mentioned that they received their wages on piece-rate basis. Also they mentioned that the wages they received were mixed both in cash and kind. It was also mentioned by Barnett and Abdelkarim (1991) that the seasonal workers are normally paid by piece rate and wages are mostly paid both in kind and in cash, whereas for settled workers the payment is solely in cash. As far as the value of the wage is concerned, it differs from one place to another and even in the same place you may find some differences in the cost of one and the same operation. However, regarding the way wages are determined in Gezira Scheme, most of the surveyed tenants mentioned that, wages are determined through bargaining process. But in some cases either the tenant determines the value or the worker is going to dictate his price. Generally during peak periods, the worker may find a chance of dictating the level of wage he desired. It may be of importance to mention that, during the bargaining process; both tenants and workers are aware of or have an idea of the current level of wages. For the tenant, information on wage levels is disseminated by other tenants in his village or nearby villages. Similarly, workers ask each other about the wage for which they have worked with some tenants (El-Jack, 1986). For example, Barnet and Abdelkarim (1991) mentioned that usually labourers from labour camps enter the market with the advantage that their work is necessary and in demand for tasks which must be done speedily. They can therefore drive a hard bargain with the tenants. On the other hand, as seasonal labourers come from diverse areas and that they entered the labour market as individuals with little or
no prior knowledge of current wage rates, their bargaining position is rather week.

Regarding the time of payment and who decides it, of course there is no fixed time of payment. Usually either the tenant or the worker specifies the time depending on the current labour situation. For the interviewed tenants, about 75% of them mentioned that, they specify the time of payment. Mostly, workers during acute shortage of labour, find themselves in a good position to decide the time of payment though only about 25% of them mentioned that they specify the time of payment.

Regarding the ethnical preference of labourers, it was observed that the tenants prefer workers from certain tribes such as those who belong to the West African tribes. For the tenants’ sample, about 66.4% of them recorded that they prefer labourers from certain tribes due to their efficiency at farm work. For those efficient workers the tenants also mentioned that they give them better wage levels compared to other inefficient workers. Usually in Gezira scheme the well trained and efficient workers are those who lived in labour camps. These camps are semi-permanent illegal homes near the tenancies in which the early migrants from Chad, Nigeria and Western Sudan settled and they participate in farm work either as hired labourers or sharecroppers. About 60% of the interviewed tenants mentioned that their labour supply source is mainly from the labour camps. This coincides with what El-Jack (1986) has reported in Gezira Scheme where in the view of many tenants, the Burgo and the Fellata are more effective in farm work than Tama and Zagawa, so they seem to be effective that they ask for higher payment than those seen as less effective. Also,
Babikir and Ahmed (1988) has given a plausible explanation for the efficient West Africans compared to the Arabs, that they had been exposed to agriculture and tedious cultural practices at home and they were more experienced farmers than the Gezira settlers who were originally pastoralists. These cultural differences have influenced attitudes towards work and the extent to which family members involve themselves in farming.

With regard to payment and efficiency differences by sex of the worker, it was noticed that, both sexes play a role in carrying out the various agricultural operations in the scheme. There are some operations completely performed by men such as irrigation and raising of field channels, while others like thinning, weeding, dropping seeds in holes and to some extent picking of cotton are mainly left for women. Concerning differences in wage levels it was observed that women are usually paid less than men. For example the per day wage rate was found to be D.S. 934.0 and D.S. 801.3 for men and women respectively.

Usually in Gezira Scheme wage rates either on piece rate basis or per day basis, was supplemented by some in-kind wages or incentives. For the interviewed tenants, about 30% of them gave incentives to workers in forms of food, shelter or feed for animals. They give incentives mostly for cotton pickers and especially for seasonal workers, as it had been mentioned by the interviewed workers. However, as reported by O’Brien (1983) in-kind wages were well known in other irrigated schemes as well as in rain-fed agriculture, where there is considerable variation in the composition of the wage and in the intensity and duration of work. About 34% Of the interviewed landless workers mentioned that
they have been given shelter and animals feed as in-kind wage, 30% were given only shelter and 29% of them food and shelter. However, O’Brien (1983) reported that, in Gezira Scheme, an intricate network of relationships has been built between the tenants and the seasonal labourers. These tied relations generally serve to maintain a high proportion of wage payments in kind, especially in the form of food and transportation costs. Also, El-Jack (1986) reported that, it is essential to emphasize the difficulty of identifying the wage and its level. For example, when the unit for piece work in given, the actual input of work will vary according to the characteristics of the particular field. In relation to the wage level, there are different elements involved in wage formation such as the cash and kind incentives paid to workers.

4.4.8.2 Wage rates on per day basis:
Regarding this type of payment, about 35% of the interviewed tenants mentioned that they did their farm work on daily wage basis. It was observed that some operations such as weeding and harvesting are usually done on piece rates basis, while others such as raising of field channels and cleaning of channels were done on daily wage basis. In this study according to what was recorded by the interviewed tenants as wage rate level in Gezira Scheme, the wage rate was estimated at SD 934.0, SD 801.3 and SD321.3 for male, female and children respectively. However the agricultural landless workers had also been asked about the level of wage with which they worked for tenants and they mentioned that it was SD 1000. To justify the disparity in wage levels between men and women in Gezira Scheme, O’Brien
(1983) argued that, the comparison of the daily rates of pay for women and men would be very misleading, because women usually work alongside men at similar rates of output, but for shorter hours due to their domestic responsibilities.

Another attempt for the estimation of wage level in Gezira Scheme was done by dividing the total cost of labour for each operation (per crop) by the total number of days spent in performing the operation. The results are presented in table (4.16). On average, the estimated wage in case of wheat production is higher relative to the other crops; this may be due to the less requirement of labour by wheat compared to the other crops. Also it is observed that on average, these wage levels are lower relative to the estimated wage level mentioned by the agricultural workers (SD 1000). This may be due to the differences in labour requirements between crops, the seasonal variations in wage levels and the differences in labour costs per operation between crops. However, in addressing wage determination in the context of the rural areas, Bardhan (1979) referred to the seasonality of labour requirements in agriculture and the role of seasonal peaks in determining wage rates at levels that would not impede the required availability of labour in the busy season. In Gezira scheme, two peak periods were observed, one at the start of the season, when sowing and resowing operations take place, and the other peak, at the harvesting time of crops. Also, there was another lighter peak period at weeding time. During these peaks tenants mentioned that wage rates were high because many agricultural operations have to be performed within a short period and landless workers may be reluctant or find it difficult to fully participate in
the labour market. As reported by El-Jack (1986) seasonality implies that terms and conditions of labour hiring are usually quite different in the peak season from other times of the year. This may be substantiated by what have been mentioned before that at harvest times, for example, usually tenants resort to some incentives to workers as an encouragement. Regarding this way of calculating wage levels, El-Bagir et al (1984) mentioned that, these figures are not entirely representative of actual wages, particularly to the harvest and post harvest operations, where a large element of non-monetary payment is usually involved in the contract.

**Table 4.16:** Wage rates per operation for production of the major field crops in Gezira Scheme (SD):

<table>
<thead>
<tr>
<th>Operation</th>
<th>Cotton</th>
<th>Wheat</th>
<th>Dura</th>
<th>Groundnut</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mesih</td>
<td>666.7</td>
<td>972.2</td>
<td>572.2</td>
<td>446.4</td>
</tr>
<tr>
<td>Sowing</td>
<td>196.8</td>
<td>-</td>
<td>311.1</td>
<td>363.6</td>
</tr>
<tr>
<td>Resowing</td>
<td>178.6</td>
<td>-</td>
<td>328.6</td>
<td>300.0</td>
</tr>
<tr>
<td>Watering</td>
<td>214.8</td>
<td>370.9</td>
<td>364.6</td>
<td>362.9</td>
</tr>
<tr>
<td>Channel cleaning</td>
<td>302.9</td>
<td>572.2</td>
<td>515.0</td>
<td>286.1</td>
</tr>
<tr>
<td>Thinning</td>
<td>250</td>
<td>-</td>
<td>500.0</td>
<td>-</td>
</tr>
<tr>
<td>Fertilizer application</td>
<td>-</td>
<td>500</td>
<td>250.0</td>
<td>-</td>
</tr>
<tr>
<td>Weeding</td>
<td>301.1</td>
<td>833.3</td>
<td>553.0</td>
<td>428.9</td>
</tr>
<tr>
<td>Harvesting</td>
<td>294.7</td>
<td>1018.5</td>
<td>550.6</td>
<td>362.2</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td>300.7</td>
<td>711.2</td>
<td>438.3</td>
<td>364.3</td>
</tr>
</tbody>
</table>

**Source:** Calculated from field survey, 2003/2004 season.
4.5 Sharecropping, migration and off-farm employment in Gezira Scheme:

4.5.1 Sharecropping practices:

The use of sharecropping as a form of labour contract is widespread in the Gezira scheme, though the scheme management board has prohibited it. Sharecropping is normally a verbal contract between a wage worker and a tenant in the scheme; it is not recognized by the Administration and is an unofficial, renewable, arrangement by which the tenant agrees not to use his or her land for a season and the worker then, as subtenant, is obliged to find all the labour required and to cultivate the holding according to the SGB’s crop rotation. The crops usually sharecropped are dura, groundnut and vegetables. Sharecropping began with dura cultivation and spread to groundnut, which, in terms of demand for labour, is second only to cotton (Barnett and Abdelkarim, 1991). For the interviewed tenants, sharecropping was only practiced in case of groundnut crop, where about 39.6% of them sharecropped it with hired labourers. Also about 31% of the landless workers mentioned that they practiced sharecropping with tenants in Gezira scheme during 2003/2004 season. Babikir (1998), during the season 1997/1998 found that about 20.2% and 44.2% of the tenants in Gezira scheme sharecropped dura and groundnut, respectively, with hired labour. Also, earlier during the season of 1983/1984 El-Jack (1986), found that, about 41% and 18.3% of his tenants’ sample practiced sharecropping in groundnut and dura respectively. During the field survey one could observe that tenants, who had off-farm jobs, for example working as
officials in the scheme, resort to either sharecropping or land rent which is locally known as ‘Dogondy’. According to the World Bank Report (2000) the social groups in Gezira scheme namely, the tenants and the migrant labourers, are dependent on each other through labour and sharecropping contracts. However, with regard to tenancy acquisition in Gezira scheme, Adam (1996) found that about 35% of his sampled tenants have their land since the scheme establishment, 40% through inheritance and 25% by other means such as transfer and illegal practices. Beside this, sharecropping has been quite common for vegetables, dura and groundnut.

From the labourer’s point of view, almost all of them in the interviewed sample mentioned that it is better for them to practice sharecropping arrangements with the tenants than to work as hired labourers, whereas, the tenants viewed sharecropping as a solution for their labour problems. From the perspective of the labourers, sharecropping provides a means of gaining access to land either for cash or subsistence cropping, without at the same time having to carry the burdens associated with the tenancy agreement (El-Bagir et al, 1984; Barnet and Abdelkarim, 1991). To substantiate these views and using some simple calculations, the total gross returns per feddan of sharecropped groundnut, which was SD 1134514.4, was divided by two to obtain the gross return per feddan for each partner. The division by two is because the agreement is based on dividing the gross returns equally between the two partners.

So each of the partners would have his gross returns per feddan as:

\[
\frac{1134514.4}{2} = \text{SD 567257.2.}
\]
To calculate the net returns for each partner, the average total costs incurred by each partner is deducted from the gross returns:

The tenant’s costs involve the cost of land preparation, seeds, land and water charges, half the cost of harvesting, transport costs and sacks and strings. This amounted to SD 14523.85. So the net returns to the tenant would be:

$$567257.2 - 14523.85 = SD\ 552733.35.$$

On the other hand, the costs paid by the labourer include the preharvest operational expenses (sowing, presowing, weeding, cleaning of field channels and irrigations), half of the harvest cost and transport, sacks and strings. This amounted to SD 11883.15. Then, the net returns for the labourer would be:

$$567257.2 - 11883.15 = SD\ 555374.05.$$

If the labourer had not entered in sharecropping arrangements with the tenant and worked for wage instead, his earnings would be the cost of the manual work he performed, and this of course is lower compared to his net returns from sharecropping. However, El-Jack (1986) who got similar results argued that, the worker will prefer sharecropping to working for wage because his earnings are higher in the former, although he has to wait for payment.

4.5.2 Migration in Gezira Scheme:

Migration is one of the vital processes, which alters significantly the size and composition of population in a given area of a country. In Sudan, a considerable part of the population movement is known to be mainly towards the urban centres mainly
to Khartoum area (internal migration). Also there is migration out of the country (international migration) and the difference between the two types of migration is called the net-migration (1993 Census Report).

Historically, the population of Sudan is known to be highly mobile as could be seen from reviewing the major population censuses since the independence of Sudan. For the whole Sudan, the 1955/1956 census revealed that about 5.5 million persons (about half of the total population) were not in their places of birth at that time. Data from 1973 census showed that about 8% of the total population (1.2 million) were not living in their province of birth. Also it revealed that the centres for attraction for the migrants were the provinces of Khartoum, Blue Nile, and Kassala. According to 1993 census, out of the 3.4 million persons who changed their usual place of residence from their state of birth, 37.5% moved from urban to urban, 30.5% from rural to urban, 9.1% from urban to rural and 22.9% from rural to rural. For the Gezira State, about 38.8% migrated from rural parts to the urban parts of other states, 33.6% from its urban parts to the urban parts of other states and 21.3% moved from rural to rural parts of other states.

The effects of migration on the labour market could be seen through its effect on labour supply situation, which will be examined in relation to the rates of change in the rural population as a whole. With the increase in rural population, the rural labour supply will increase (El-Jack, 1986). Table (4.17) shows the extent to which the rural population changed during the periods of different censuses that occurred in Sudan. The table also gives the
increases in urban population. From the table it is clear that the rural population increased by almost 2.8 millions between the first and the second censuses, while the urban population increased by about 1.8 million during the same period. During the period 1973 – 1983, the rural population increased by 5.2 millions and the urban population by 1.9 million. However, from 1983 to 1993, the increase in rural population was estimated at 16.5 millions and that of urban population was about 6.2 millions.

**Table 4.17:** Rural and urban population of the Sudan changes during the periods of national censuses

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>737 (7.2)</td>
<td>2488 (16.9)</td>
<td>4361 (20.2)</td>
<td>6285052 (25.2)</td>
</tr>
<tr>
<td>Rural</td>
<td>9525 (92.8)</td>
<td>12270 (83.1)</td>
<td>17411 (80.6)</td>
<td>16535673 (66.3)</td>
</tr>
</tbody>
</table>

Figures in brackets are percentages of total population.

**Source:** Calculated from population censuses.

Migration has been important to the Gezira scheme, as it has played a historical role in the provision of labour to the scheme. The availability of employment opportunities in the Gezira Scheme could be an attractive factor for the migrant labour (El-Jack, 1986). The use of seasonal labour is noticeable in areas where cash crop production is dominant and where demand for labour is high (Yousif, 1985). From the sample of the landless
workers, about 33.3% of them were migrant workers who used to come to Gezira Scheme at cotton picking time. They mentioned that their contract of employment is usually some variant of piecework and payment in kind. Some of them brought their animals with them for feeding, a practice always not obliged by the Gezira management. However, O’Brien (1983) reported that, experience in Gezira Scheme showed that large supplies of wage labour would be required on seasonal basis, especially to pick cotton. The result was the formation of a vast system of seasonal labour migration as a result of the British policies devised to stimulate them. Among the interviewed landless workers, about 35% of them were ethnically of West African origin. This may reflect the historical roots of migration to Gezira scheme. As reported by O’Brien (1983) that in response to upward pressures on cotton-picking piece rates in the early depression years, the government adopted a policy of encouraging the settlement in and around the Gezira area of West African immigrants. The World Bank Report (2000) mentioned the following pull factors for immigration and camp settlements in Gezira Scheme:

- Encouragement of the labourers to have areas to cultivate sorghum.
- Tenants help labourers in building their camps.
- Recruitment of labourers for cotton picking.
- Share cropping and land lease systems gave the labourers the opportunity to become producers.
- The trend for West Africans to take up the Sudanese nationality.
• Encouragement by some political parties for the migrants to settle in the area to increase the voting population.

However, available studies by the Socio-economic Unit of the Gezira Board show that the scheme saw in-migration of labourers up to the 1989/90 season. Since then there has been a decline in the number of migrants seeking work in the scheme. From the estimated average tenant household in this study (7.6), about 1.7 persons (22.4%) represented rate of internal migration. Mostly, the migration took the form of rural to urban migration, mainly to Khartoum area; this represented about 90% of the migrated cases. For the external migration, about 1.5 persons (19.7%), on average, were recorded. The respondents mentioned that the out migrants were mostly to Arabic Petroleum countries and few were to other countries. In relation to the out-migration, about 38% of the interviewed tenants mentioned that they received remittances from their sons abroad. However, in the World Bank Report (2000) it was reported that, these remittances help to reduce the impact of the decline in agricultural production and consequently earnings in Gezira Scheme. However, Barnet and Abdelkarim (1991) reported that the labour market and production relations in the irrigated areas are now affected strongly by proximity to the urban areas of the Sudan, particularly the three towns, together with the increased demand during the past ten years for certain types of labour by other Middle Eastern countries, notably in the Gulf and Libya.
4.5.3 Off-farm employment in Gezira Scheme:

As mentioned before, the off-farm income, on average, represented about 43.9% of the average total household income in Gezira Scheme. Though sometimes the tenants were very reluctant to disclose their incomes, but almost about 53 (35.3%) of them mentioned that they have other sources of non-agricultural income. They also mentioned that agriculture had been for them a non-profitable job that they have to diversify their incomes for survival. The World Bank Report (2000) found that there is a sense of serious social inequality in the Gezira. Tenants’ incomes are declining in real terms and no doubt the earnings from farming for some put them below the poverty line. Their only strategy is to augment their incomes through off-farm work.

On average, about 2.03 persons of tenants’ households mentioned that they have off-farm jobs. They mainly represented tenants’ sons who have better education and find a possibility of white-collar jobs. On average, the off-farm job is estimated at SD 282617.4 per tenant out of which about SD 53293.1 (18.9%) represents an average of non-labour form of income as remittances. Table (4.18) presents the distribution of tenants according to off-farm activity in Gezira scheme. It is clear from the table that about 37.7% of them gain their off-farm incomes from small trading, 43.5% of them work as wage labourers on per day basis, 11.3% are employed either in the scheme or in other jobs and few of them (7.5%) have made some sort of large trading compared to the others.
Table 4.18: The distribution of tenants having off-farm incomes according to their off-farm activities:

<table>
<thead>
<tr>
<th>Item</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-skilled labour</td>
<td>23</td>
<td>43.5</td>
</tr>
<tr>
<td>Skilled labour</td>
<td>6</td>
<td>11.3</td>
</tr>
<tr>
<td>Small business</td>
<td>20</td>
<td>37.7</td>
</tr>
<tr>
<td>Large business</td>
<td>4</td>
<td>7.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>53</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

*Source: Calculated from field survey, 2003/2004 season.*
CHAPTER FIVE  
ECONOMETRIC ANALYSIS

This chapter presents and discusses the empirical results of the econometric analysis. In the first section of this chapter, the analysis concerning the production functions is presented and discussed. The second section presents and discusses the results of regression analysis for labour demand and supply. The third section is concerned with wage determination and incomes in Gezira Scheme.

5.1 The production function approach

5.1.1 Model specification:

The estimation of the production function is to help in:

- Analyzing the output response to labour input, human capital and farm production characteristics.
- Testing for the efficiency of the labour market and assessing shadow wages of labour.

In this study, the following general form of a production function was specified:

\[ Y = AX_1\beta_1 X_2\beta_2 \ldots \ldots \ldots X_n\beta_n + \epsilon. \]

Where:

- \( Y \) = the average total output of crop taken in kilograms.
- \( A \) = an intercept.
- \( \beta_1, \beta_2, \ldots, \beta_n \) = the coefficients (elasticities).
- \( X_1, X_2, \ldots, X_n \) = the independent variables.
- \( \epsilon \) = the error term.
A Cobb-Douglas (log-log) transformation was used in the following general form:

\[
\text{Logy} = \log a + \beta_1 \log X_1 + \beta_2 \log X_2 + \cdots + \beta_n \log X_k + \epsilon.
\]

The parameters of the function are the elasticities of output with respect to the factors of production. The use of Cob-Douglas also permits the phenomenon of diminishing marginal returns without losing many degrees of freedom. Regarding the heterogeneity nature of labour into family and hired labour, for each crop there were two specified functions.

The dependent variable (Y) is the average total output of crop per tenancy taken in kilograms. However, two sets of Cobb-Douglas equations were specified in this study. In the first one, the labour input is the total labour required by the crop per farm, while in the second set this total is disaggregated into family and hired categories. The independent variables include continuous and dummy variables. Dummy variables are used to estimate the effect of the factors, which are not easily measured as physical quantities. These dummy variables are not converted into logarithmic forms, as the logarithm of zero is undefined. In this study the independent variables used are:

- \(X_1 = \) area cultivated for each crop in feddans.
- \(X_2 = \) total labour required by each crop in mandays.
- \(X_{10} = \) total family labour required by each crop in mandays.
- \(X_{11} = \) total hired labour required by each crop in mandays.
- \(X_3 = \) capital expenses (SD).
- \(X_4 = \) number of irrigations.
- \(X_5 = \) number of weedings.
X6 = tenant age.
X7 = educational level, in years.
X8 = sowing date (dummy: 1 for early sowing, 0 otherwise).
X9 = harvesting (dummy: 1 for early harvesting, 0 otherwise).

5.1.2 Empirical results of regression equations:

In this study, four equations for cotton, wheat, dura and groundnut were estimated, depending on the correlation matrices, the coefficient of multiple determinations (R²), the adjusted R², the significance of the overall model as judged by the F-value, the significance of the independent variable coefficients as shown by the t-values and the appropriateness of the signs of the regression coefficients. Originally many variables were tried in the model but the estimation procedure has excluded the irrelevant ones (on statistical basis). The final specified equations were obtained after many trials using the SPSS/PC computer program. Enter multiple regression was applied which run the regression and order the independent variables according to their t-values. However, for the sake of minimizing the effects of multi-colinearity and other statistical problems, some independent variables, such as, the family size, the farm income and off-farm income were excluded from the specified equations.

5.1.2.1 Cotton regression equations:

Table (5.1) presents the first cotton regression equation in which the dependent variable is the average total yield per tenancy in kilograms. The continuous independent variables include area of cotton in feddan, total labour per tenancy in man-days, capital expenses (SD), number of irrigations, number of weedings, tenant
age and educational levels in years. The dummy variables include sowing date (0,1) where zero stands for the optimum sowing and one for the late sowing and harvesting date (0,1) where zero stands for early harvesting and one stands for late harvesting. As shown in the table the explanatory power of the equation is moderately high (0.664) and the F-value has a good fit regarding the overall significance of the model.

**Table 5.1: Cotton regression equation (1):**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>Standard errors</th>
<th>T-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultivated area (Fed.)</td>
<td>0.264</td>
<td>0.256</td>
<td>1.031</td>
</tr>
<tr>
<td>Total labour (mandays)</td>
<td>0.480</td>
<td>0.085</td>
<td>5.647***</td>
</tr>
<tr>
<td>Capital expenses (SD)</td>
<td>0.303</td>
<td>0.172</td>
<td>1.762*</td>
</tr>
<tr>
<td>Number of irrigations</td>
<td>0.161</td>
<td>0.128</td>
<td>1.258</td>
</tr>
<tr>
<td>Number of weedings</td>
<td>0.005</td>
<td>0.093</td>
<td>0.054</td>
</tr>
<tr>
<td>Tenant age, years</td>
<td>0.507</td>
<td>0.150</td>
<td>3.380***</td>
</tr>
<tr>
<td>Educational level, in years</td>
<td>0.102</td>
<td>0.035</td>
<td>2.914**</td>
</tr>
<tr>
<td>Sowing date (dummy)</td>
<td>0.059</td>
<td>0.050</td>
<td>1.180</td>
</tr>
<tr>
<td>Harvesting date (dummy)</td>
<td>-0.131</td>
<td>0.049</td>
<td>-2.673**</td>
</tr>
<tr>
<td>Constant</td>
<td>1.554</td>
<td>0.608</td>
<td>2.556**</td>
</tr>
</tbody>
</table>

F-value: 24.531 (0.000). $R^2 = 0.644$ $R^{-2} = 0.618$

*, ** and *** denotes significance at 10%, 5% and 1% levels respectively.

**Source:** Calculated from field survey, 2003/2004 season.

Table (5.2) shows the results of the second cotton regression equation, which is the same as the first one except that the labour variable has been disaggregated into family and hired labour inputs.
Table 5.2: Cotton regression equation (2):

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>Standard errors</th>
<th>T-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultivated area (Fed.)</td>
<td>0.051</td>
<td>0.287</td>
<td>0.178</td>
</tr>
<tr>
<td>Family labour (md)</td>
<td>0.069</td>
<td>0.018</td>
<td>3.833***</td>
</tr>
<tr>
<td>Hired labour (md)</td>
<td>0.094</td>
<td>0.042</td>
<td>2.238**</td>
</tr>
<tr>
<td>Capital expenses (SD)</td>
<td>0.789</td>
<td>0.264</td>
<td>2.989***</td>
</tr>
<tr>
<td>Number of irrigations</td>
<td>0.367</td>
<td>0.133</td>
<td>2.759***</td>
</tr>
<tr>
<td>Number of weedings</td>
<td>0.115</td>
<td>0.102</td>
<td>1.127</td>
</tr>
<tr>
<td>Tenant age, years</td>
<td>0.132</td>
<td>0.137</td>
<td>0.964</td>
</tr>
<tr>
<td>Educational level, in years</td>
<td>0.068</td>
<td>0.036</td>
<td>1.889*</td>
</tr>
<tr>
<td>Sowing date (dummy)</td>
<td>0.167</td>
<td>0.052</td>
<td>3.212***</td>
</tr>
<tr>
<td>Harvesting date (dummy)</td>
<td>-0.165</td>
<td>0.050</td>
<td>3.300***</td>
</tr>
<tr>
<td>Constant</td>
<td>1.765</td>
<td>0.679</td>
<td>2.599**</td>
</tr>
</tbody>
</table>

F-value: 12.407 (0.000). $R^2 = 0.528$ $R^{-2} = 0.495$

*, ** and *** denotes significance at 10%, 5% and 1% levels respectively.

Source: Calculated from field survey, 2003/2004 season.

5.1.2.2 Wheat regression equations:

Table (5.3) presents the first wheat regression equation in which the dependent variable is the average total yield per tenancy in kilograms. The continuous and dummy independent variables are the same as those for cotton, except that, the variable for weeding is not included in wheat equation because tenants usually do light weeding to this crop. The specified model gave a very good fit to the data with R-squared of 0.704 and R-bar-squared of 0.686. Also the F-value of 39.851 that is significant at all levels of
significance with all variables have the expected signs with their coefficients having different t-values.

**Table 5.3:** Wheat regression equation (1):

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>Standard errors</th>
<th>T-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultivated area (Fed.)</td>
<td>0.275</td>
<td>0.153</td>
<td>1.797*</td>
</tr>
<tr>
<td>Total labour (mandays)</td>
<td>0.201</td>
<td>0.106</td>
<td>1.896*</td>
</tr>
<tr>
<td>Capital expenses (S.D)</td>
<td>0.328</td>
<td>0.145</td>
<td>2.2621**</td>
</tr>
<tr>
<td>Number of irrigations</td>
<td>0.147</td>
<td>0.136</td>
<td>1.081</td>
</tr>
<tr>
<td>Tenant age, years</td>
<td>0.087</td>
<td>0.046</td>
<td>1.891*</td>
</tr>
<tr>
<td>Educational level, years</td>
<td>0.014</td>
<td>0.016</td>
<td>0.875</td>
</tr>
<tr>
<td>Sowing date (dummy)</td>
<td>0.195</td>
<td>0.026</td>
<td>7.500***</td>
</tr>
<tr>
<td>Harvesting date (dummy)</td>
<td>-0.245</td>
<td>0.037</td>
<td>-6.622***</td>
</tr>
<tr>
<td>Constant</td>
<td>2.788</td>
<td>0.390</td>
<td>7.149***</td>
</tr>
</tbody>
</table>

F-Value: 39.851 (0.000). R2 = 0.704. R-2 = 0.686.

*, ** and *** denotes significance at 10%, 5% and 1% levels respectively.

**Source:** Calculated from field survey, 2003/2004 season.

Table (5.4) shows the results for the second wheat equation in which the labour variable is disaggregated into family and hired categories. In this equation, the model fits the data well as indicated by the statistics of the $R^2$ and the F-value. The explanatory variables of area, family labour, hired labour, number of irrigation and education level show a good level of statistical significance and have the expected signs.
Table 5.4: Wheat regression equation (2):

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>Standard error</th>
<th>T-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultivated area (Fed.)</td>
<td>0.478</td>
<td>0.221</td>
<td>2.163*</td>
</tr>
<tr>
<td>Family labour (md)</td>
<td>0.283</td>
<td>0.088</td>
<td>3.216***</td>
</tr>
<tr>
<td>Hired labour (md)</td>
<td>0.157</td>
<td>0.071</td>
<td>2.211*</td>
</tr>
<tr>
<td>Capital expenses (S.D)</td>
<td>0.118</td>
<td>0.306</td>
<td>0.386</td>
</tr>
<tr>
<td>Number of irrigations</td>
<td>0.627</td>
<td>0.184</td>
<td>3.408***</td>
</tr>
<tr>
<td>Tenant age, years</td>
<td>0.112</td>
<td>0.200</td>
<td>0.556</td>
</tr>
<tr>
<td>Educational level, years</td>
<td>0.102</td>
<td>0.056</td>
<td>1.821*</td>
</tr>
<tr>
<td>Sowing date (dummy)</td>
<td>0.063</td>
<td>0.055</td>
<td>1.145</td>
</tr>
<tr>
<td>Harvesting date (dummy)</td>
<td>-0.033</td>
<td>0.078</td>
<td>-0.423</td>
</tr>
<tr>
<td>Constant</td>
<td>4.608</td>
<td>0.853</td>
<td>5.402***</td>
</tr>
</tbody>
</table>

F-Value: 7.488 (0.000). $R^2 = 0.605$. $R^{-2} = 0.562$.

*, ** and *** denotes significance at 10%, 5% and 1% levels respectively.

Source: Calculated from field survey, 2003/2004 season.

5.1.2.3 Sorghum regression equations:

Table (5.5) presents the first sorghum regression equation in which the dependent variable is the average total yield per tenancy in kilograms. The independent variables are similar to those for cotton and wheat, except that the harvesting date is (0,1,2) where zero stands for harvesting date (1$^{st}$ to 15$^{th}$ November), one for the harvesting date (16$^{th}$ to the end of November) and two for the harvesting date (1$^{st}$ to mid December). The specified model gave a good fit to the data with, $R^2$ of 0.579, $R^{-2}$ of 0.548 and f-value of 18.612, which are significant at all reasonable levels of significance.
Table 5.5: Sorghum regression equation (1):

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>Standard error</th>
<th>T-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultivated area (Fed.)</td>
<td>0.258</td>
<td>0.138</td>
<td>1.869*</td>
</tr>
<tr>
<td>Total labour (md)</td>
<td>0.371</td>
<td>0.054</td>
<td>6.870***</td>
</tr>
<tr>
<td>Capital expenses (S.D.)</td>
<td>0.389</td>
<td>0.117</td>
<td>3.325**</td>
</tr>
<tr>
<td>Number of irrigations</td>
<td>0.239</td>
<td>0.082</td>
<td>2.915**</td>
</tr>
<tr>
<td>Number of weedings</td>
<td>0.001</td>
<td>0.058</td>
<td>0.017</td>
</tr>
<tr>
<td>Tenant age, years</td>
<td>0.034</td>
<td>0.095</td>
<td>0.358</td>
</tr>
<tr>
<td>Educational level, years</td>
<td>0.028</td>
<td>0.026</td>
<td>1.077</td>
</tr>
<tr>
<td>Sowing date (dummy)</td>
<td>-0.025</td>
<td>0.035</td>
<td>-0.714</td>
</tr>
<tr>
<td>Harvesting date (dummy)</td>
<td>-0.022</td>
<td>0.026</td>
<td>-0.846</td>
</tr>
<tr>
<td>Constant</td>
<td>2.977</td>
<td>0.272</td>
<td>10.945***</td>
</tr>
</tbody>
</table>

F-value: 18.612 (0.000). $R^2 = 0.579$. $R^{-2} = 0.548$.

*, ** and *** denotes significance at 10%, 5% and 1% levels respectively.

Source: Calculated from field survey, 2003/2004 season.

Table (5.6) shows the results for the second sorghum equation in which the labour variable is disaggregated into family and hired categories. In this equation, as indicated by the F-value (12.089), $R^2$ (0.579) and $R^{-2}$ (0.531), the specified model shows a moderately good fit to the data. The variation in output is explained by family labour, hired labour, capital expenses, number of irrigation and number of weedings explanatory variables.
Table 5.6: Sorghum regression equation (2):

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>Standard error</th>
<th>T-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultivated area (Fed.)</td>
<td>0.650</td>
<td>0.138</td>
<td>4.493***</td>
</tr>
<tr>
<td>Family labour (md)</td>
<td>0.063</td>
<td>0.034</td>
<td>1.853*</td>
</tr>
<tr>
<td>Hired labour (md)</td>
<td>0.082</td>
<td>0.022</td>
<td>3.727***</td>
</tr>
<tr>
<td>Capital expenses (S.D.)</td>
<td>0.248</td>
<td>0.103</td>
<td>2.408*</td>
</tr>
<tr>
<td>Number of irrigations</td>
<td>0.168</td>
<td>0.088</td>
<td>1.909*</td>
</tr>
<tr>
<td>Number of weedings</td>
<td>0.185</td>
<td>0.057</td>
<td>3.246***</td>
</tr>
<tr>
<td>Tenant age, years</td>
<td>-0.067</td>
<td>0.100</td>
<td>-0.670</td>
</tr>
<tr>
<td>Educational level, years</td>
<td>0.008</td>
<td>0.029</td>
<td>0.276</td>
</tr>
<tr>
<td>Sowing date (dummy)</td>
<td>-0.029</td>
<td>0.031</td>
<td>-0.935</td>
</tr>
<tr>
<td>Harvesting date (dummy)</td>
<td>0.006</td>
<td>0.023</td>
<td>0.261</td>
</tr>
<tr>
<td>Constant</td>
<td>3.625</td>
<td>0.264</td>
<td>13.731***</td>
</tr>
</tbody>
</table>

F-value: 12.089 (0.000). $R^2 = 0.579$. $R^2 = 0.531$.

*, ** and *** denotes significance at 10%, 5% and 1% levels respectively.

Source: Calculated from field survey, 2003/2004 season.

5.1.2.4 Groundnut regression equations:

Table (5.7) presents the first groundnut regression equation in which the dependent variable is the average total yield per tenancy in kilograms. The independent variables are similar to those for the previous crops, except for sowing and harvesting dates. The sowing date is (0, 1, 2, 3) where zero stands for sowing date (1st to 15th of June), one, for sowing date (16th to end of June), two, for sowing date (1st to 15th of July), three, for sowing date (16th to end of July). Also for the harvesting date four groups were recorded (0,1,2,3), where zero for harvesting date (15th to the end
of October), one, for harvesting date (1st to 15th of November), two for the harvesting date (16th to the end of November) and three for the harvesting date (1st to 15th of December). The specified model fitted the data very well with; R² of 0.654 and R-² of 0.626 and F-value of 22.714 that is significant at all levels of significance. Total labour, cost of variable inputs, sowing date and harvesting dates variables show a high level of statistical significance with expected signs.

Table 5.7: Groundnut regression equation (1):

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>Standard errors</th>
<th>T-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultivated area (Fed.)</td>
<td>0.112</td>
<td>0.078</td>
<td>1.436</td>
</tr>
<tr>
<td>Total labour (md)</td>
<td>0.396</td>
<td>0.128</td>
<td>3.094***</td>
</tr>
<tr>
<td>Capital expenses(S.D.)</td>
<td>0.405</td>
<td>0.080</td>
<td>5.063***</td>
</tr>
<tr>
<td>Number of irrigations</td>
<td>0.029</td>
<td>0.059</td>
<td>0.492</td>
</tr>
<tr>
<td>Number of weedings</td>
<td>0.043</td>
<td>0.047</td>
<td>0.915</td>
</tr>
<tr>
<td>Tenant age, years</td>
<td>0.021</td>
<td>0.028</td>
<td>0.750</td>
</tr>
<tr>
<td>Educational level, years</td>
<td>0.001</td>
<td>0.008</td>
<td>0.125</td>
</tr>
<tr>
<td>Sowing date (dummy)</td>
<td>0.108</td>
<td>0.019</td>
<td>5.684***</td>
</tr>
<tr>
<td>Harvesting date (dummy)</td>
<td>-0.096</td>
<td>0.018</td>
<td>-5.333***</td>
</tr>
<tr>
<td>Constant</td>
<td>3.262</td>
<td>0.159</td>
<td>20.516***</td>
</tr>
</tbody>
</table>

F-value: 22.714 (0.000).  R² = 0.654.  R-² = 0.626.
*, ** and *** denotes significance at 10%, 5% and 1% levels respectively.
Source: Calculated from field survey, 2003/2004 season.
Table (5.8) shows the results for the second groundnut equation in which the labour variable is disaggregated into family and hired categories. The statistics of F-value (41.515), R2 (0.857) and R-2 (0.837) imply a very good fit of the data to the specified model. The most important variables in explaining the variations in groundnut yield are area, family labour, hired labour, capital expenses and number of irrigations as indicated by their coefficients’t-values.

Table 5.8: Groundnut regression equation (2):

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>Standard errors</th>
<th>T-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultivated area (Fed.)</td>
<td>0.602</td>
<td>0.114</td>
<td>5.281***</td>
</tr>
<tr>
<td>Family labour (md)</td>
<td>0.087</td>
<td>0.038</td>
<td>2.289*</td>
</tr>
<tr>
<td>Hired labour (md)</td>
<td>0.113</td>
<td>0.063</td>
<td>1.794*</td>
</tr>
<tr>
<td>Capital expenses (S.D.)</td>
<td>0.351</td>
<td>0.114</td>
<td>3.079***</td>
</tr>
<tr>
<td>Number of irrigations</td>
<td>0.521</td>
<td>0.251</td>
<td>2.076*</td>
</tr>
<tr>
<td>Number of weedings</td>
<td>0.317</td>
<td>0.232</td>
<td>1.366</td>
</tr>
<tr>
<td>Tenant age, years</td>
<td>0.405</td>
<td>0.278</td>
<td>1.457</td>
</tr>
<tr>
<td>Educational level, years</td>
<td>0.039</td>
<td>0.059</td>
<td>0.661</td>
</tr>
<tr>
<td>Sowing date (dummy)</td>
<td>-0.096</td>
<td>0.082</td>
<td>-1.171</td>
</tr>
<tr>
<td>Harvesting date (dummy)</td>
<td>0.106</td>
<td>0.077</td>
<td>1.377</td>
</tr>
<tr>
<td>Constant</td>
<td>0.218</td>
<td>0.559</td>
<td>0.389</td>
</tr>
</tbody>
</table>

F-value: 41.515 (0.000). R² = 0.857. R-2 = 0.837.

* *, ** and *** denotes significance at 10%, 5% and 1% levels respectively.

Source: Calculated from field survey, 2003/2004 season.
5.1.3 Regression equations: Discussion

The interpretation of the independent variables can be as follows:

5.1.3.1 Labour variable:

The labour variable has coefficients (elasticities) of 0.480, 0.201, 0.371 and 0.396 for cotton, wheat, sorghum and groundnut respectively. These elasticities are significantly different from zero at different levels of significance. These elasticities are read as increasing the labour input by 1% increases the yield by 0.480%, 0.201%, 0.371% and 0.396% for cotton, wheat, sorghum and groundnut respectively (tables 5.1, 5.3, 5.5 and 5.7). These elasticities are very high relative to the expected ones, which are known to be very low in the developing countries. However, El-Feil (1993) suggested the following reasons for these high elasticities in Sudanese agriculture:

- The coefficient of the labour variable picks up the effects of the labour shortage in periods of planting, weeding and harvesting.
- Within the crop growing season, the actual labour hours are very little relative to the length of growing season, i.e. these high elasticities, in fact represent only few months of the whole season.
- The regression model may fail to take account of the period over which the work is done and hence exaggerate these elasticities.
- Also regarding the wheat crop, which requires less labour input than other crops and recalling that, the actual amount
of labour engaged in the different agricultural operations may be very little relative to the total amounts of labour available throughout the year; this may exaggerate the magnitudes of the coefficients in the model.

Many similar results in the context of Gezira Scheme assured that the labour variable was significantly an important factor of agricultural production in Gezira scheme (El-Amin, 1981; Babikir, 1998; and Babikir and El-Feil 2003).

**5.1.3.2 Cultivated area:**

This variable has got coefficients of 0.264, 0.275, 0.258 and 0.112 for cotton, wheat, sorghum and groundnut respectively (tables 5.1, 5.3, 5.5 and 5.7). These coefficients are not significantly different from zero, except for wheat crop. However, this variable in the equations where labour input was used as two variables has the coefficients of 0.051, 0.478, 0.650 and 0.602 for cotton, wheat, sorghum and groundnut respectively (tables 5.2, 5.4, 5.6 and 5.8). These coefficients are significantly different from zero at different levels of significance, except for cotton. The non-significance may be ascribed to that the assigned land allotment for these crops by the SGB makes little variation among tenants with respect to area cultivated (Babikir, 1998). There is a lot of debate over the inclusion of the cropped area as an explanatory variable in production function analysis (Narayanasamy, 1997). The significance of this variable in case of the wheat crop is not strange considering the fragmentation of land tenure that occurred in the scheme during years. The issue of land fragmentation is recognized by most of the tenants as being a
serious problem to the viability of the scheme. The average size of the allocated tenancy has tended to decline with the creation of many half-tenancies, while on the other hand, there is an increasing trend of absentees tenants and the use of wakeel system. This has caused an increased fragmentation in the actual farm size, while the registered and official land holding has not necessarily diminished in size (World Bank Report, 2000).

5.1.3.3 Family labour:

This variable has got coefficients of 0.069, 0.283, 0.063 and 0.087 for cotton, wheat, sorghum and groundnut respectively (tables 5.2, 5.4, 5.6 and 5.8). These coefficients are significantly different from zero for all crops.

5.1.3.4 Hired labour:

This variable has got coefficients of 0.094, 0.157, 0.082 and 0.113 for cotton, wheat, sorghum and groundnut respectively (tables 5.2, 5.4, 5.6 and 5.8). These coefficients are significantly different from zero for all crops.

5.1.3.5 Capital expenses:

This variable represents all those items of capital used up in the production process, excluding labour costs, as they entered the equation in physical units, also capital stock assets were excluded.

This variable has got coefficient of 0.303, 0.328, 0.389 and 0.405 for cotton, wheat, dura and groundnut respectively. These coefficients are significantly different from zero for cotton, sorghum and groundnut, and that for wheat is not significantly different from zero at any level of significance (Tables 5.1, 5.3, 5.5
and 5.7). Similar results were obtained by El-Amin (1981); Babikir (1998) and Babikir and El-Feil (2003). Regarding the sets of equations where labour input is divided into family and hired categories, the coefficients of this variable are 0.789, 0.118, 0.248 and 0.351 for the studied crops respectively (Tables 5.2, 5.4, 5.6 and 5.8). Again these coefficients are significantly different from zero for all crops except wheat crop. The non-significance of this variable in case of wheat may be due to the little variation among farmers with respect to the capital expenses and the amount of this variable may be little, on average, relative to the total costs of production (field survey, 2003/2004)

5.1.3.6 Number of irrigations:

This variable was measured as the number of irrigations per season. Studies by the Socio-economic Research Unit in Gezira Scheme (2002) assured that the productivity of crops increase with the number of irrigations. The tenants who receive a number of irrigations, which is closer to the recommended number, have a higher yield than those who do not. This variable has coefficients of 0.161, 0.147, 0.239 and 0.029 for cotton, wheat, sorghum and groundnut respectively (Tables 5.1, 5.3, 5.5 and 5.7). These coefficients are only significantly different from zero in case of sorghum, which may be due to that the tenants may use all the available water for crop production and the fact that, sorghum is the main staple crop in Gezira area that is inevitably grown by all the interviewed tenants. Hence more variation among the tenants is expected relative to the other crops. However, (as shown in tables 5.2, 5.4, 5.6 and 5.8) this variable has the coefficients of 0.367,
0.627, 0.168 and 0.521 for cotton, wheat, sorghum and groundnut respectively. These coefficients are significantly different from zero at different levels for all crops.

5.1.3.7 Number of weedings:

This variable was measured as the number of weedings during the season. It has got the coefficients of 0.005, 0.001 and 0.043 for cotton, sorghum and groundnut respectively (tables 5.1, 5.3, 5.5 and 5.7). The coefficients of this variable in case of the disaggregated labour input equations are 0.115, 0.185 and 0.317 for cotton, sorghum and groundnut respectively (Tables 5.2, 5.4 and 5.8). Usually tenants in Gezira Scheme do light or no weeding to the wheat crop, that is why this variable has not been used in case of wheat crop. None of the coefficients of this variable is significantly different from zero at any level of significance for all crops in both sets of equations. This may be due to that the tenant when asked about the number of weedings; they usually mentioned the recommended level, even if they do not actually do it (field survey, 2003/2004).

5.1.3.8 Tenant age:

The age (years) of a farmer can be used as a proxy for measuring general farming experience (Kanwar, 1998; Banin and Brummer, 2000). Banin and Brummer (2000) who used age as a proxy for experience in a Cobb-Douglas function in the context of Botswana farmers reported that the expected effect of age is an empirical question. It may be that older farmers have more experience in the production system and are better able to assess the risks involved in farming than younger farmers. On the other
hand, it is also possible that age can influence production negatively, in the sense that younger farmers have experienced a better quality of education. Their results showed a significant negative effect of age on crop production.

This variable has the coefficients of 0.507, 0.087, 0.034 and 0.021 for cotton, wheat, sorghum and groundnut respectively. These coefficients are significantly different from zero in case of cotton and wheat crops at 1% and 10% level of significance respectively, whereas, they are not significantly different from zero at any level of significance in case of sorghum and groundnut (Tables 5.1, 5.3, 5.5 and 5.7). As shown in tables (5.2, 5.4, 5.6 and 5.8) age variable has the coefficient of 0.123, 0.112, 0.067 and 0.405 for the studied crops respectively, with none of them having significant impact on crop outputs.

5.1.3.9 Educational level:

Human capital is generally expected to be an important determinant of productivity and may be a proxy for management effect in household production (Cook, 1999). This variable is measured by the years of schooling completed by the respondent. All else equal, education should be positively related to crop productivity, because education may enable household members to better understand information regarding new farm technologies, and may increase both allocative and technical efficiency of the household (Banin and Brummer, 2000). An important factor in determining a farmer’s entrepreneurial ability is his education, which is usually measured in terms of the number of years of formal education of the household head (Kanwar, 1998). Yang
(1997) conducted production function analysis to assess the role of education in production using Chinese data. However, Cook (1999) with data from rural China found a negatively significant effect of education on agricultural production. He explained his result by that better educated tenants are more likely to move their productive members into off-farm employment.

The coefficients of this variable are 0.102, 0.014, 0.028 and 0.001 for cotton, wheat, sorghum and groundnut respectively (Tables 5.1, 5.3, 5.5 and 5.7). This variable has a positive effect on production of the studied crops that is statistically significant at 5% level in case of the cotton crop. The non-significance of this variable in case of other crops may be due to that the Gezira tenants were known as homogenous with respect to education level (Babikir, 1998). Tables (5.2, 5.4, 5.6 and 5.8) show the coefficients of 0.068, 0.102, 0.008 and 0.039 for the studied crops respectively in case where labour input is categorized into family and hired labour. These coefficients show a significant effect on output for cotton and wheat only. Babikir (1998) and Babikir and El-Feil (2003) used education in dummy form in production function analysis in the context of Gezira Scheme. His results assured the positive effect of education but it was non-significant. However, it was mentioned that in the context of developing countries, few studies found a positive and statistically significant effect of farmers’ schooling on farm output. This seems to be for that, schooling levels may have been too low to be productive and variance in schooling levels may have been too small (Huffman, 2001).
5.1.4 Test of labour market efficiency:

Resource inadequacy for developing countries’ agricultural growth has often been a major concern of economists. In these countries there is the prevalence of numerous distortions in input markets. Some of these distortions are introduced by government policies, some others are rooted in the inequitable socioeconomic structure. The shadow price of an input is specified in the literature as the product of its own market price and an input-specific distortion factor. The immense population pressure in rural areas and the lack of employment opportunities outside agriculture tend to depress the market wage rate. Generally, the coexistence of numerous noncompetitive forces, government regulations, and offsetting interlinkages makes the structure of market prices an inadequate signal for input allocation. Farmers’ resource allocation decisions are based on opportunity costs rather than market prices (Bhattacharyya and Kumbhakar, 1997).

In order to test whether the labour market functions efficiently, the relationship between the estimated marginal products and effective wage is examined. Assuming that farm households maximize their utility, the marginal productivity of work on the family farm should be equal to the effective wage received by family members working off the farm. Under the additional assumption of no transport costs, the effective wage should equal their reported market wage. This suggests that, under the maintained hypothesis of utility maximization, a test for the equality of shadow wages and the observed wages could shed some light on the presence of transaction costs or frictions in the rural labour market (Deolalikar and Vijverberg, 1987; Jacoby,
1993; Skoufias, 1994; Lambert and Magnac, 1997; Lamb and Worthington, 2003; Barrett, et al, 2005). The distinction between shadow wages and the marginal revenue product of labour may be important to empirical work in estimating structural labour supply functions in places where these sorts of structural frictions are commonplace and where many labourers earn no observable wages (Barrett, et al, 2005). Comparing implicit prices of inputs and their market prices allow us to better analyze the response of farmers in less developed countries to price incentives (Lambert and Magnac, 1997). In regions where wages are poor proxies for labour returns adequate estimates of labour returns can instead be obtained by estimating shadow wages using an agricultural production function (Linde, 2001). Behaviour under perfect markets implies separability between production and consumption decisions (Squire and Strauss, 1986). Market failures affect household behaviour and imply non-separability between production and consumption. In the context of these two extremes, many tests were done, among which, the test for non-separation where a production function or cost function is estimated, then the marginal productivity (i.e. the shadow price) of an input, can be compared to the market price. The test is not specific to failure on one particular market, as failure on any market will induce non-separable behaviour (Vakis and Sadoulet, 2004; Bowlus and Sicular, 2003). Bhattacharyya and Kumbhakar (1997) used a generalized indirect production function, defined in terms of shadow prices and shadow cost to calculate the extent of price distortions, their effects on input allocation and also on expenditure-constrained maximal output.
Lamb and Worthington (2003) assessed the efficiency of the rural labour markets in Burkina Faso on the assumption that the household labour will be supplied to the point that its marginal product equates with the real wage. Specifically, they used the following test:

$$W^* = \alpha + \beta W_m + e$$

Where:

- $W^*$ is the shadow wage rate,
- $W_m$ is the prevailing market wage, and
- $e$ is the error term.

The test will support labour market efficiency, if $\alpha = 0$ and $\beta = 1$ and $e$ is the error term and the rejection of this null hypothesis is that F-value is significant at any level of significance. Thus this test will be used in this study as a preliminary assessment for the labour market performance in Gezira Scheme.

The production function provides a measure of the technical relationship between inputs and total output. That is, given the household’s labour allocation decision; it provides a measure of the returns to labour in a particular activity. The Cobb-Douglas specification of the production function yields the coefficient of labour $\beta$ for a particular factor of production, which is the elasticity of that factor. The marginal revenue product of labour in agriculture is calculated by dividing the total output value by the number of labour days input into agricultural production, thus giving the average output value per day of labour input. This average revenue product of labour is multiplied by the coefficient on labour from the estimated model to give the marginal revenue
product of labour (Cook, 1999). The estimated regression coefficients for the studied crops will be used for the calculation of the mean marginal value product of labour (MVP) applying the following formula:

\[ \frac{\delta Y}{\delta X2} = \frac{1}{Y} \times \frac{\beta 2}{X2}. \]

Where:

\[ \frac{\delta Y}{\delta X2} = \text{the mean marginal product of labour.} \]

\[ \beta 2 = \text{the estimated regression coefficient of labour.} \]

\[ Y = \text{average value of crop yield.} \]

\[ X = \text{average value of labour use on farm.} \]

The mean marginal value (MMV) = the mean marginal product (MMP) multiplied by the average output selling price.

The marginal cost of a resource is the cost of the additional unit of its purchase price. For the labour resource, which is categorized into family and hired labour, usually the cost of family labour services is estimated on the basis of information on the number of family workers in the different agricultural operations, which is then multiplied by the imputed annual wage of hired labour. Hence the total costs of the labour services were estimated using wages of hired labour to family labour (Babikir, 1998). During the field survey a deflated wage rate of SD 701.0 (2.26 in real values) per one man-day was estimated as prevailing wage rate in Gezira scheme, on average (field survey, 2003/2004). This wage rate will be used for the comparison between the shadow price (MMV) and the market price in this study. Generally speaking, the results of the mean marginal values of labour (Table
5.9) confirm the commonly known low returns to labour in agricultural production, especially in cases of sorghum and groundnut crops. For cotton and wheat crops, the shadow price (MMV) seemed to be nearly similar to the market wage. However, these differences in MMVs between crops, according to Babikir (1998), could be explained by the following reasons:

- Differences between crops in total labour requirements and average yields.
- The estimation of the regression equation for groundnut may be affected by the practice of sharecropping.
- The regression model may fail to account for the differences due to change in labour quality, and timing of agricultural operations.
- The estimated average labour requirements per tenancy may be over-estimated i.e. cotton and wheat.
- Tenants in Gezira Scheme are not free to select their enterprises; they follow a prescribed crop rotation. In this regard, Cook (1999) reported that variations in marginal returns to labour stem from institutional arrangements which constrain the free allocation of labour.

These results may tend to support the common assumption of very low marginal productivity of labour in the developing countries (Radwan, 1989; El-Fiel, 1993). This low marginal productivity makes labour as if it is over-invested, which may go in line with the phenomenon of surplus labour that exists in the developing countries (Cook, 1999).
Empirical work on surplus labour to date has focused primarily on its estimation at an aggregate level; little evidence exists to show whether the concept of surplus labour accurately characterizes the condition of rural households and how it affects household labour allocation and returns to labour. The simplest definition of surplus labour implies the existence of some point at which the marginal product of labour becomes zero. A broader definition that does not require the zero marginal productivity is that it is the reservation wage which is the minimum level of compensation required to make the labour not to leave the farm and is greater than zero but below the wage rate in the nonagricultural labour market. A better measure of this reservation wage is the marginal revenue product of labour or the shadow wage. So for households allocating labour between agricultural and nonagricultural activities, we expect marginal returns to be equalized across activities so that \( w = \text{MP}_{\text{agr}} = \text{MP}_{\text{nonagr}} \) (Cook, 1999). Accordingly in this study, the marginal value product of agricultural labour will be compared to the market wage in the agricultural sector and that in the nonagricultural sector. This may shed some light on the phenomenon of surplus labour and migration out of agricultural areas, in spite of the fact that in this study the marginal value product of labour in nonagricultural production is not specified. Calculated from the comprehensive industrial survey (2005) the market wage for the unskilled nonagricultural workers was estimated at SD 1256.2 per day. The market wage for the agricultural workers as mentioned before was SD 701.0 and the shadow price of labour estimated from the production function was SD 681.7, 953.8, 463.0 and 218.0 for
cotton, wheat, sorghum and groundnut respectively. As stated before, these shadow wages are significantly different from the ruling market wage. They are also different and lower compared to the ruling wage in nonagricultural activities. The results again confirm the low returns to labour in agriculture, implying a sense of surplus labour and provides some evidence that market forces play a role in the allocation of labour outside agriculture whereas, the allocation of labour in agriculture may be affected by other nonmarket forces such as household characteristics and government policies (Cook, 1999).

Table 5.9: Production elasticities mean marginal products (MMPs) and mean marginal values (MMVs) of labour categories for the production of the major field crops in Gezira scheme:

<table>
<thead>
<tr>
<th>Crop</th>
<th>Elasticity</th>
<th>MMPs</th>
<th>MMVs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton</td>
<td>0.480</td>
<td>4.874</td>
<td>681.7</td>
</tr>
<tr>
<td>Wheat</td>
<td>0.201</td>
<td>17.271</td>
<td>953.8</td>
</tr>
<tr>
<td>Sorghum</td>
<td>0.371</td>
<td>11.079</td>
<td>463.0</td>
</tr>
<tr>
<td>Groundnut</td>
<td>0.396</td>
<td>4.448</td>
<td>218.0</td>
</tr>
</tbody>
</table>

Source: Calculated from field survey, 2003/2004 season.

Table (5.10) presents the results of the test of equality between shadow wages and effective wages in the study area. As shown by the results, the F-values are significant in case of the four crops, which may be an evidence of rejecting the null hypothesis that the shadow wages significantly deviated from their market wage. Thus the test of the efficiency of the rural labour
market in Gezira scheme demonstrate that markets do not behave as predicted by the neoclassical theory. In this regard, labour allocations are made on the basis of shadow rather than market prices. This result may be explained in the light of the following arguments:

- The deviation between shadow wages and market wages may be related to the household characteristics (Benjamin, 1992; Barrett, et al, 2005).
- There may be employment constraints in the rural labour market that prevent households from equating the marginal returns between activities (Skoufias, 1994).
- The equality of shadow and market wages may fail to hold in reality because of some transaction costs or imperfections in the labour market (Jacoby 1993).
- The market wage may be understated given that some workers may have received some in-kind payments (Lamb and Worthington, 2003).
- Seasonality of labour demand and supply may impose some constraints on household allocation and substitution between different categories of labour (Skoufias, 1994).
- The data may include measurement errors and the estimated marginal products may in fact be systematically biased and hence non-consistent estimates of $\alpha$ and $\beta$ (Lamb and Worthington, 2003; Jacoby, 1993).
Table 5.10: Test of equality of estimated labour shadow wages and prevailing market wages in Gezira scheme:

<table>
<thead>
<tr>
<th>Crop</th>
<th>Initial $R^2$</th>
<th>Initial F-value</th>
<th>Constant</th>
<th>Log wage ($\beta$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton</td>
<td>0.339</td>
<td>4.652</td>
<td>0.647</td>
<td>0.758**</td>
</tr>
<tr>
<td></td>
<td>(0.087)</td>
<td>(0.648)</td>
<td>(2.157)</td>
<td></td>
</tr>
<tr>
<td>Wheat</td>
<td>0.391</td>
<td>3.229</td>
<td>0.205</td>
<td>-0.643</td>
</tr>
<tr>
<td></td>
<td>(0.077)</td>
<td>(2.029)**</td>
<td>(-1.797)*</td>
<td></td>
</tr>
<tr>
<td>Sorghum</td>
<td>0.301</td>
<td>2.972</td>
<td>0.411</td>
<td>-0.518</td>
</tr>
<tr>
<td></td>
<td>(0.087)</td>
<td>(3.262)**</td>
<td>(-1.724)*</td>
<td></td>
</tr>
<tr>
<td>Groundnut</td>
<td>0.404</td>
<td>3.142</td>
<td>0.404</td>
<td>-0.785</td>
</tr>
<tr>
<td></td>
<td>(3.206)**</td>
<td>(3.206)**</td>
<td>(-1.773)*</td>
<td></td>
</tr>
</tbody>
</table>

Source: Calculated from field survey, 2003/2004 season.

5.1.5 The productivity of family and hired labour inputs:

The productivity of agricultural labour is central to any discussion of rural development (Rahji and Falusi, 2005). The new direction of investigation in labour time allocations treats men and women and even children as different types of workers each with his own shadow value of time or marginal productivity (Jacoby, 1992). In this study following the idea of Deolalikar and Vijverberg (1987), the emphasis is on estimating labour time marginal productivities of family and hired categories of labour within the Gezira tenants’ households and to assess their shadow wages based on the assumption of their heterogeneity. According to Deolalikar and Vijverberg (1987) the sources of heterogeneity between family and hired labour could be due to the following:

- The family and hired labour may have different composition of male versus female, adult versus child, and skilled versus unskilled labour. So this would tend to drive down the
marginal product of family relative to hired labour, since in many less developed countries there is a social stigma attached to females and children work.

- The skill differential between family and hired labour may also be an important source of heterogeneity. The greater skill level associated with hired labour relative to family labour would then increase its marginal product and also affect the degree of substitution between family and hired labour.

- The differences between family and hired labour could also be explained in terms of seasonality.

- There is a large literature on agricultural dualism in less developed countries that, owing to limited alternative employment opportunities, the shadow price of time is low for family members. Hired labour, however, has to be paid the going wage rate. Therefore, there is a tendency to depress the marginal product of family labour to a lower level than that of hired labour.

- The performance of managerial and supervisory tasks by family members may also reduce the substitutability between family and hired labour.

- The output effects of family and hired labour may differ because of the different incentives they face. Since family workers have an ownership interest in their farms, they might put forth a larger effort and hence a greater marginal product than hired workers.
Thus it appears, however, that it is difficult to predict a priori which of the two types of labour will have a larger effect on output. Given the gender specificity of agricultural tasks in most developing countries (e.g. Skoufias, 1993; Jacoby 1992), and the existing evidence on the heterogeneity between family and hired labour (Deolalikar and Vijverberg, 1987), in this study at least, family and hired labour were specified as having different effect on agricultural output. Therefore another set of Cobb-Douglas functions were specified with the variable of total labour disaggregated into family and hired categories to assess their different effects on crop outputs per tenancy in Gezira scheme.

Generally, referring to the World Bank Report (2000), it is shown that the Gezira tenants’ reliance on hired labour is in increase every season. Also referring to the descriptive analysis in this study, it is shown that for the production of the major field crops in Gezira scheme, on per feddan basis, only about 28.5% of these crops labour requirements is from family sources. The remaining (71.5%) portion comprises the share of hired labour in production that is relatively large compared to family labour. In the Cobb-Douglas analysis, the coefficients of both family and hired labour with respect to their output in all crops are significantly important in explaining output variation (Tables 5.2, 5.4, 5.6, and 5.8). This may imply that both family and hired labour categories are affecting output at different levels of importance. Regarding family labour these coefficients are 0.069, 0.283, 0.063 and 0.087 for cotton, wheat, sorghum and groundnut respectively. The coefficients of hired labour associated with output variations are 0.094, 0.157, 0.082 and 0.113 for cotton,
wheat, sorghum and groundnut respectively. However, the expected results in case of wheat and groundnut may be that the hired and family labourers, respectively, have no significant effects on output. This is because wheat operations are mostly done by family labourers since it is a semi-mechanized crop and in case of groundnut the operations are mostly done by hired labourers who sharecropped it with the tenant (Field survey 2003/2004). From table 5.11, it is clear that for cotton and wheat the marginal effect exerted by the family labour on their outputs is higher relative to that of hired labour. This result could be explained in light of the fact that both crops are government crops and the tenant is expected not to pay much to have hired labour efforts. Also the result could be explained in view of the seasonality of farm work and supervision effects of family labour (Deolalikar and Vijverberg, 1987). On the other hand, hired labour seems to have greater effect on output of both sorghum and groundnut crops compared to family labour. However, this is expected since these crops are known in the scheme as the tenant’s crops. The differences due to sex, task or even skills, as well as the effect of seasonality may have made hired labour more productive relative to family labour. In addition to this, the result of groundnut may be explained in the light of the sharecropping practice.
Table 5.11: Elasticities, marginal products and mean marginal values of family and hired labour categories for the production of the major field crops in Gezira scheme:

<table>
<thead>
<tr>
<th>Crop</th>
<th>Labour category</th>
<th>Elasticity</th>
<th>MMPs</th>
<th>MMVs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton</td>
<td>Family labour</td>
<td>0.069</td>
<td>2.659</td>
<td>372.0</td>
</tr>
<tr>
<td></td>
<td>Hired labour</td>
<td>0.094</td>
<td>1.2976</td>
<td>181.5</td>
</tr>
<tr>
<td>Wheat</td>
<td>Family labour</td>
<td>0.283</td>
<td>41.946</td>
<td>2307.0</td>
</tr>
<tr>
<td></td>
<td>Hired labour</td>
<td>0.157</td>
<td>31.319</td>
<td>1722.5</td>
</tr>
<tr>
<td>Sorghum</td>
<td>Family labour</td>
<td>0.063</td>
<td>5.746</td>
<td>240.1</td>
</tr>
<tr>
<td></td>
<td>Hired labour</td>
<td>0.082</td>
<td>8.184</td>
<td>343.5</td>
</tr>
<tr>
<td>Groundnut</td>
<td>Family labour</td>
<td>0.113</td>
<td>4.703</td>
<td>230.6</td>
</tr>
<tr>
<td></td>
<td>Hired labour</td>
<td>0.087</td>
<td>16.936</td>
<td>830.2</td>
</tr>
</tbody>
</table>

Source: Calculated from field survey, 2003/2004 season.
5.2 The determinants of labour demand and supply: Empirical results and discussion:

5.2.1 The determinants of labour demand: Empirical results and discussion:

In this study, for the specification of the determinants of labour demand in Gezira scheme, the following log-linear model is used:

\[ L_{di} = \beta_0 + \beta_{11}HHSIZ + \beta_{21}PRP + \beta_{31}ELDP + \beta_{41}EDU + \beta_{51}WAG + \beta_{61}AGE + \beta_{71}TAREA + \beta_{81}REXINP + \beta_{91}ATPR + \beta_{101}OUTP + \beta_{111}RIC + \beta_{121}TRINC + \beta_{121}DM_1 + \beta_{121}DM_2 \]

Where:

- \( L_{di} \) = average (family, hired or total) labour use per farm in the season, in mandays.
- \( \beta_0 \) is the intercept.
- \( \beta_1 \) to \( \beta_{12} \) are parameters of explanatory variables.
- \( HHSIZ \) = household size.
- \( PRP \) = number of prime persons in the household.
- \( ELDP \) = number of elder persons in the household.
- \( EDU \) = education variable in total years of schooling.
- \( WAG \) = average wage rates, S.D. per one manday.
- \( AGE \) = age of the household head.
- \( TAREA \) = average of total cultivated area, in feddans.
- \( REXINP \) = average expenditure on variable inputs, SD per feddan.
- \( ATPR \) = average total production per tenancy in kilograms.
- \( OUTPRIC \) = average output price, SD per sack.
- \( TRINC \) = average tenant real income per year in SD.
- \( DM_1 \) = probability of having off-farm job.
- \( DM_2 \) = ethnical preference.
Table (5.12) presents the econometric results of family labour demand determinants in Gezira Scheme in which the dependent variable is the average total family labour used per tenancy during the season, 2003/2004 for the production of the four major field crops, namely cotton, wheat, sorghum and groundnut. The independent variables represent a set of demographic and non-demographic variables. The specified model gave a good fit to the data with; F-value of 6.707, which is significant at all levels of significance, $R^2$ of 0.770 and $R^{-2}$ of 0.731. Multi-collinearity does not appear to cause any problem as most of the variables are passing the t-test at some reasonable levels and most of them have the expected signs with their coefficients having different t-values (El-Feil, 1993). The demographic variables were proxied by the tenant age, the family size, the number of prime persons in the household and the number of elder persons in the household (Benjamin, 1992). Among the demographic variables, the average household size and tenant age have a positive and significant effect on family labour demand at 5% level of significance. Larger households perhaps requiring less labour and the older the family members, as proxied by the age of the household head, the more difficult would it be for them to provide the labour requisite for doing the on-farm chores (Kanwar, 1998). The significant effect of the household size on labour demand may imply that production of field crops in Gezira Scheme support larger families and represent one of the important sources of their consumption requirements. Education, measured in years of schooling also has a positive and significant effect on family labour demand. As stated by Kanwar (1998) education may have unclear effect on labour demand. The
educated ones tend to be averse to manual labour (Bardhan, 1984). If, however, it is not possible to work off-farm for any reason i.e. lack of off-farm opportunities, then a higher education may not translate into a higher demand for labour (Kanwar, 1998). Among the technological factors, capital expenses, average total production and average output price have positive and significant effects on family labour demand. However, according to Kanwar (1998) the use of complementary inputs to labour, such as fertilizers, high yielding varieties, farm implements etc., has commensurate increments in the demand for labour, and it is preferable to lump together the expenditures on these inputs to assess their effect on labour demand as a package. The wage rate though has the expected sign, has no significant effect on family labour use. This is not strange recalling that mostly family workers were not given a specified wage level in Gezira Scheme (field survey, 2003/2004).
Table 5.12: Determinants of family labour demand: (dep. var.: average total family labour demand in man-days, log form)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>Standard errors</th>
<th>T-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>1.749</td>
<td>0.843</td>
<td>2.074*</td>
</tr>
<tr>
<td>Household size (log)</td>
<td>0.525</td>
<td>0.202</td>
<td>2.599**</td>
</tr>
<tr>
<td>Tenant age (log)</td>
<td>0.901</td>
<td>0.343</td>
<td>2.627**</td>
</tr>
<tr>
<td>Tenant education</td>
<td>0.189</td>
<td>0.067</td>
<td>2.821**</td>
</tr>
<tr>
<td>No. prime persons (log)</td>
<td>0.155</td>
<td>0.138</td>
<td>1.123</td>
</tr>
<tr>
<td>No. elder persons (log)</td>
<td>-0.102</td>
<td>0.121</td>
<td>-0.843</td>
</tr>
<tr>
<td>Real wage rate (log)</td>
<td>-0.204</td>
<td>0.540</td>
<td>-0.378</td>
</tr>
<tr>
<td>Capital expenses (log)</td>
<td>0.903</td>
<td>0.290</td>
<td>3.114***</td>
</tr>
<tr>
<td>Average total production, Kg. (log)</td>
<td>0.502</td>
<td>0.248</td>
<td>2.024*</td>
</tr>
<tr>
<td>Real tenant income (log)</td>
<td>0.140</td>
<td>0.097</td>
<td>1.443</td>
</tr>
<tr>
<td>Off-farm income (dum.)</td>
<td>-0.048</td>
<td>0.046</td>
<td>-1.043</td>
</tr>
<tr>
<td>Ethnical preference</td>
<td>-0.049</td>
<td>0.045</td>
<td>-1.099</td>
</tr>
<tr>
<td>Average output price, S.D. (log)</td>
<td>0.616</td>
<td>0.283</td>
<td>2.177*</td>
</tr>
</tbody>
</table>

F-value: 6,707 (0.000). $R^2 = 0.770$. $R^2 = 0.731$

*, ** and *** denotes significance at 10%, 5% and 1% levels respectively.

Source: Calculated from field survey, 2003/2004 season.

Table (5.13) presents the results of hired labour demand determinants in Gezira Scheme, in which the average total hired labour used per tenancy during the season 2003/2004 for the studied crops is the dependent variable. The specified model has fitted the data very well as can be detected from the F and $R^2$ values. The average number of elder persons in the tenant household has a positive and significant effect on hired labour demand, implying that the dependence on hired labour is more, the larger the number of elder persons in the tenant family. The real
wage rate has a negative and highly significant effect on hired labour demand, implying low farm employment at higher wage rates. This result is in conformity with that of Kanwar (1998, 2005) in the context of India. Also capital expenses, tenant income and output price have positive and significant effects on hired labour use.

**Table 5.13:** Determinants of the hired labour demand: Dep. variable: average total hired labour demand in man-days (log form).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>Standard errors</th>
<th>T-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>1.941</td>
<td>0.399</td>
<td>4.865***</td>
</tr>
<tr>
<td>Household size (log)</td>
<td>0.073</td>
<td>0.094</td>
<td>0.778</td>
</tr>
<tr>
<td>Tenant age (log)</td>
<td>0.046</td>
<td>0.186</td>
<td>0.247</td>
</tr>
<tr>
<td>Tenant education</td>
<td>0.023</td>
<td>0.037</td>
<td>0.622</td>
</tr>
<tr>
<td>No. prime persons (log)</td>
<td>-0.034</td>
<td>0.081</td>
<td>-0.420</td>
</tr>
<tr>
<td>No. elder persons (log)</td>
<td>0.120</td>
<td>0.071</td>
<td>1.690*</td>
</tr>
<tr>
<td>Real wage rate (log)</td>
<td>-0.682</td>
<td>0.216</td>
<td>-3.157***</td>
</tr>
<tr>
<td>Capital expenses (log)</td>
<td>0.628</td>
<td>0.057</td>
<td>11.018***</td>
</tr>
<tr>
<td>Average total production, fed. (log)</td>
<td>0.125</td>
<td>0.135</td>
<td>0.926</td>
</tr>
<tr>
<td>Real tenant income (log)</td>
<td>0.174</td>
<td>0.047</td>
<td>3.702***</td>
</tr>
<tr>
<td>Off-farm income (dum.)</td>
<td>-0.002</td>
<td>0.025</td>
<td>-0.080</td>
</tr>
<tr>
<td>Average output price, S.D. (log)</td>
<td>0.536</td>
<td>0.147</td>
<td>3.646***</td>
</tr>
<tr>
<td>Ethnical preference (dum.)</td>
<td>-0.004</td>
<td>0.026</td>
<td>-0.154</td>
</tr>
</tbody>
</table>

F-value: 31.869 (0.000).  \( R^2 = 0.748, \quad R^2 = 0.724 \)

*, ** and *** denotes significance at 10%, 5% and 1% levels respectively.

**Source:** Calculated from field survey, 2003/2004 season.

Table (5.14) shows the results pertaining to the determinants of the total labour demand for the production of the major field crops in Gezira Scheme.
Shifts in demand for agricultural labour can come from changes in output market conditions or from technical change. Labour demand depends on variables such as the demographic composition of the labour-buying household, the size of the farm, the extent of irrigation, the multiple-cropping pattern and the demand shifts with busy or slack seasons (Bardhan, 1984). Household size, education and the average number of prime persons in the tenant household have significant effect on total labour demand. The positive and significant effect of the number of prime persons on labour demand implies that presence of different roles done by different gender and the tasks done by persons in this age category contribute more to the production of field crops in Gezira scheme. The real wage rate has a negative and significant effect on labour demand. A similar result was obtained by Benjamin (1992) using data from rural Java and Kanwar (2004) with data from India. However, Bardhan using Indian data found a positive significant effect of wages on labour demand. Both the output price and the off-farm income have significant effects on total labour demand. Capital expense also is a highly significant determinant of the total labour demand with large elasticity associated with it (0.87) implying that the package of technology utilized has been labour using and not labour displacing (Kanwar, 1998).
Table 5.14: Determinants of the total labour demand: (Dep. variable: average total labour demand in man-days (log form))

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>Standard errors</th>
<th>T-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>1.165</td>
<td>0.292</td>
<td>3.990***</td>
</tr>
<tr>
<td>Household size (log)</td>
<td>0.129</td>
<td>0.073</td>
<td>1.767*</td>
</tr>
<tr>
<td>Tenant age (log)</td>
<td>0.063</td>
<td>0.129</td>
<td>0.488</td>
</tr>
<tr>
<td>Tenant education</td>
<td>0.075</td>
<td>0.027</td>
<td>2.778**</td>
</tr>
<tr>
<td>No. prime persons (log)</td>
<td>0.251</td>
<td>0.061</td>
<td>4.115***</td>
</tr>
<tr>
<td>No. elder persons (log)</td>
<td>0.053</td>
<td>0.054</td>
<td>0.981</td>
</tr>
<tr>
<td>Real wage rate (log)</td>
<td>-0.485</td>
<td>0.235</td>
<td>-2.064*</td>
</tr>
<tr>
<td>Capital expense (log)</td>
<td>0.878</td>
<td>0.119</td>
<td>7.378***</td>
</tr>
<tr>
<td>Average total production, fed. (log)</td>
<td>0.014</td>
<td>0.098</td>
<td>0.143</td>
</tr>
<tr>
<td>Real tenant income (log)</td>
<td>0.046</td>
<td>0.036</td>
<td>1.278</td>
</tr>
<tr>
<td>Average output price, S.D. (log)</td>
<td>0.906</td>
<td>0.118</td>
<td>7.678***</td>
</tr>
<tr>
<td>Off-farm income (dum.)</td>
<td>0.073</td>
<td>0.037</td>
<td>1.973*</td>
</tr>
<tr>
<td>Ethnical preference (dum.)</td>
<td>0.021</td>
<td>0.020</td>
<td>1.050</td>
</tr>
</tbody>
</table>

F-value: 14.108 (0.000).  \( R^2 = 0.579. \)  \( R^2 = 0.548. \)

*, ** and *** denotes significance at 10%, 5% and 1% levels respectively.

Source: Calculated from field survey, 2003/2004 season.

5.2.2 The determinants of labour supply: Empirical results and discussion:

In this study, for the specification of the determinants of labour supply in Gezira scheme, the following log-linear model is used:

\[
L_{si} = \beta_0 + \beta_1\text{HHSIZ} + \beta_2\text{AGE} + \beta_3\text{ELDP} + \beta_4\text{EDU} + \beta_5\text{WAG} + \beta_6\text{PRP} + \beta_7\text{TAREA} + \beta_8\text{REXINP} + \beta_9\text{OUTPRIC} + \\
\beta_{10}\text{AREA} + \beta_{11}\text{ARGINC} + \beta_{12}\text{DSTWN} + \beta_{13}\text{TROFINC} + \beta_{14}\text{DSVIL} + \\
\beta_{15}\text{DAYIL} + \beta_{16}\text{ATPR} + \beta_{17}\text{DM}_1 + \beta_{18}\text{DM}_2 + e.
\]
Where:

$L_{si} = \text{average (family, hired or total) labour use per farm in the season, in mandays.}$

$\beta_0$ is the intercept, $\beta_1$ to $\beta_{12}$ are parameters of explanatory variables.

HHSIZ = household size.

AGE = average age in years.

ELDP = number of elder persons in the household.

EDU = education variable in total years of schooling.

WAG = average real wage rate, SD per one manday.

PRP = average number of prime persons in the household.

TAREA = average of total cultivated area, in feddans.

REXINP = average expenditure on variable inputs, SD per feddan.

OUTPRIC = average output price per kilogram in SD.

ARGTINC = average real gross tenant income per season in SD.

DSTWN = average distant to the nearest town in kilometres.

TROFINC = average real off-farm income per year in SD.

DSVIL = average distant to from the tenancy to the village in kilometres.

DAYIL = average number of days ill.

ATPR = average total production per tenancy in kilograms.

$DM_1 = \text{the effect of sharecropping (dummy variable).}$

$DM_2 = \text{ethnical preference}$

$e = \text{error term.}$

Table (5.15) presents the results of the determinants of the family labour supply in Gezira Scheme, in which the dependent variable is the average total family labour supply for the
production of the major field crops in Gezira Scheme, season 2003/2004. The decision of farmers to work on or off the farm depends in part on household composition and the participation patterns of other family members (Kimhi 1996). In Gezira Scheme, it was noticed that, the size and composition of the tenants’ families are very important factors in shaping the nature and magnitude of family labour supply (Adam, 1996). Among the demographic variables, the average household size, tenant age, number of prime persons and the number of elder persons in the household have positive and significant effects on family labour supply. However, the effect of age variable on family labour supply is negative and significant. In the context of Gezira tenant households, the tenant’s age is expected to explain part of the variation in the amount of labour supply from each tenant household, because a similar cyclic development of individual age seems to be exhibited by the tenant household. That is, a young newly married tenant will have only young children who cannot supply labour, so a low contribution to farm labour supply is expected at this stage. At a middle stage, when the tenant’s son is grown up and can contribute with him in farm work, then at this stage the labour supply is expected to increase with the increase in tenant’s age. When the tenant gets older, almost all his sons become independent and the tenant himself is physically unable to supply farm labour, so the household labour supply is expected to move in an opposite direction with the increase in tenant’s age (El-Jack, 1986). This cyclical effect of age on labour supply was also emphasized by Barnet and Abdelkarim, (1991). Therefore, the negative relationship between the supply of labour and age is
expected because this negative effect corresponds with the late stage in the cyclical tenant household development (El-Jack, 1986). Similar results regarding the effect of age on labour supply was reported by El-Jack (1986) and Mohammed (1979) who found the same effect on both male and female family labour supply to cotton picking in New Halfa Scheme. He also got a similar result for the effect of family size on labour supply. Unexpectedly, the real wage rate has a positive significant effect on family labour supply. Hence for the cultivating households the relevant wage rate variable may be their imputed incomes or the opportunity cost on working on their own farms (Bardhan, 1979). Capital expenses are positively and significantly affect family labour supply at 10% level of significance. The variable distance from town, which is used to pick the effect of availability of off-farm jobs in the nearest town, has a negative and significant effect on family labour supply. This may imply that the availability of non-farm employment is expected to limit the supply of tenant household labour to farming. For this variable, El-Jack (1986) found that it is negatively significant in its effect on family labour supply in Gezira Scheme. The negative sign of the variable distance from the village is expected because the distance of the tenancy seems to add to the drudgery of work and increases its disutility to the household member. The non-significance of this variable may be ascribed to some tenants whose tenancies are far from their residence resorting to labour in villages and camps adjacent to their tenancies to perform farm work. This seems to alleviate the adverse effect of the remoteness of the tenancy on family labour supply (El-Jack, 1986).
Table 5.15: Determinants of the family labour supply:

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>Standard errors</th>
<th>T-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>3.231</td>
<td>0.613</td>
<td>5.271***</td>
</tr>
<tr>
<td>Household size, persons (log)</td>
<td>0.094</td>
<td>0.039</td>
<td>2.410*</td>
</tr>
<tr>
<td>average age, years (log)</td>
<td>-0.410</td>
<td>0.140</td>
<td>-2.929**</td>
</tr>
<tr>
<td>Tenant education, years</td>
<td>-0.050</td>
<td>0.033</td>
<td>-1.515</td>
</tr>
<tr>
<td>No. prime persons (log)</td>
<td>0.271</td>
<td>0.066</td>
<td>4.106***</td>
</tr>
<tr>
<td>No. elder persons (log)</td>
<td>-0.128</td>
<td>0.064</td>
<td>-2.005*</td>
</tr>
<tr>
<td>Real wage rate, S.D. (log)</td>
<td>0.376</td>
<td>0.068</td>
<td>5.529***</td>
</tr>
<tr>
<td>Capital expenses, S.D. (log)</td>
<td>0.388</td>
<td>0.208</td>
<td>1.865*</td>
</tr>
<tr>
<td>Total cultivated area, fed. (log)</td>
<td>0.409</td>
<td>0.250</td>
<td>1.636</td>
</tr>
<tr>
<td>Real gross tenant income, S.D. (log)</td>
<td>0.040</td>
<td>0.035</td>
<td>1.143</td>
</tr>
<tr>
<td>Distance from town, Km. (log)</td>
<td>-0.141</td>
<td>0.056</td>
<td>-2.518**</td>
</tr>
<tr>
<td>Distance from village, Km. (log)</td>
<td>-0.008</td>
<td>0.046</td>
<td>-0.174</td>
</tr>
<tr>
<td>No. of days ill (log)</td>
<td>-0.050</td>
<td>0.044</td>
<td>-1.136</td>
</tr>
<tr>
<td>Average total production, Kg. (log)</td>
<td>0.086</td>
<td>0.126</td>
<td>0.683</td>
</tr>
<tr>
<td>Ethnical preference (dum.)</td>
<td>0.026</td>
<td>0.023</td>
<td>1.130</td>
</tr>
</tbody>
</table>

F-value: 7.148, (0,000). $R^2 = 0.547$. $R^2 = 0.514$.

*, ** and *** denotes significance at 10%, 5% and 1% levels respectively.

Source: Calculated from field survey, 2003/2004 season.

Table (5.16) shows the details of the determinants of hired labour supply for the studied crops, where the average total hired labour supply per tenancy represents the dependent variable. Tenant age, total cultivated area and real wage rate have a highly significant effect on hired labour supply. Regarding the age variable, it was reported by Yousif (1985) that there is a close relationship between age and labour supply. This stems from the fact that most of those of age 20 to 59 years have direct and more family
obligations, and are more experienced, in contrast to younger ones. The real wage rate has a highly significant positive effect on hired labour supply. This result is in line with Kanwar (1998, 2005) with Indian data and El-Jack (1986) in the context of Gezira Scheme and Mohammed (1979) with data from New Halfa Scheme. However, Bardhan (1979) and Rosenzweig (1980) using data from India found a negative significant effect of wages on hired labour supply. Capital expenses, tenant income and average total production have positive and significant effects on hired labour supply. In addition to social and economic factors, demand conditions strongly influence the labour supply behaviour of men and women in the local labour market (Bardhan, 1984). A dummy variable to pick the effect of sharecropping practices on labour supply is used and it has a positive significant effect on hired labour supply. This is expected as the tenants resort to sharecropping practices as a solution to their labour problems (field survey, 2003/2004).
Table 5.16: Determinants of hired labour supply:

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>Standard errors</th>
<th>T-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>2.123</td>
<td>0.551</td>
<td>3.854***</td>
</tr>
<tr>
<td>Tenant age, years, (log)</td>
<td>0.387</td>
<td>0.128</td>
<td>3.023***</td>
</tr>
<tr>
<td>Total cultivated area, Fed. (log)</td>
<td>0.203</td>
<td>0.041</td>
<td>4.951***</td>
</tr>
<tr>
<td>Real wage rate, S.D., (log)</td>
<td>0.198</td>
<td>0.052</td>
<td>3.808***</td>
</tr>
<tr>
<td>Capital expenses, SD., (log)</td>
<td>0.425</td>
<td>0.199</td>
<td>2.136**</td>
</tr>
<tr>
<td>Real tenant income, (log)</td>
<td>0.123</td>
<td>0.045</td>
<td>2.733**</td>
</tr>
<tr>
<td>Real off-farm income, S.D. (log)</td>
<td>-0.016</td>
<td>0.043</td>
<td>-0.372</td>
</tr>
<tr>
<td>Ethnical preference, (dum.)</td>
<td>0.015</td>
<td>0.026</td>
<td>0.577</td>
</tr>
<tr>
<td>Average total production, Kg. (log)</td>
<td>0.332</td>
<td>0.131</td>
<td>2.534**</td>
</tr>
<tr>
<td>Tenant’s household size</td>
<td>0.009</td>
<td>0.030</td>
<td>0.300</td>
</tr>
<tr>
<td>Sharecropping effect, (dum.)</td>
<td>0.088</td>
<td>0.032</td>
<td>2.750**</td>
</tr>
</tbody>
</table>

F-value: 14.538 (0.000). $R^2 = 0.550$. $R^{-2} = 0.525$.

*, ** and *** denotes significance at 10%, 5% and 1% levels respectively.

Source: Calculated from field survey, 2003/2004 season.

Table (5.17) presents the results that pertain to the total labour supply in Gezira Scheme, where the dependent variable is the average total labour supply during the season 2003/2004 for the production of the studied crops. Tenant education has a negative significant effect on labour supply. Yousif (1985) who studied labour supply in Gezira Scheme (1985) found a negative and significant relationship between education and male labour supply. It seems that in Gezira Scheme where the enrolment rate is likely to be high, young generations who are more educated than older ones, are less likely to inherit farming experience from their fathers or enter the agricultural labour market (Yousif, 1985). More
general, in the context of Rural Pakistan, Fafchamps and Quisumbing (2002) found that households with better educated males earn higher off-farm income and divert labour resources away from farm activities towards non-farm work. However, Maglad (1998) found a significant positive effect of education on women labour supply to the urban labour market in Sudan. The average number of prime age persons in the household negatively and significantly affects the total labour supply. It implies that generally the larger the size of the prime aged persons in the tenant household, the lesser would be the total labour supply to farm work (Kanwar, 1998). Capital expenses and average cultivated area both have highly significant effects on total labour supply. The variable average distance from nearest town was entered as proxy to pick the effect of availability of off-farm jobs. It turned out to be negative and significant in relation to the total labour supply to farm work. Similar results were obtained by El-Jack (1986) and Yousif (1985). The effect of sharecropping on labour supply (dummy variable) is negatively significant. This negative effect may be explained by the fact that with the increasing tendency of tenants to share crops, the worker may not find it necessary to accept specification of any level of labour input since he can find many tenants anxious to offer sharecropping contracts. Also this practice mostly occurred due to the lacking of financial resources to hire labour (El-Jack, 1986). The variable ethnical preference is a dummy variable to pick the effect of ethnicity on labour supply. Ethnicity is a good indicator of the influence of a complex of socio-cultural factors on labour participation (Yousif, 1985). It has a negative significant effect on labour supply. Many
studies in Gezira Scheme as surveyed by Yousif (1985) indicated that non-Arabs have higher labour supply (in flow terms) than Arabs. For Yousif (1985), the effect of ethnicity is positive and statistically significant. Also in the context of Blue Nile areas, Babikir and Ahmed (1988) found that the West African tribes have a higher rate of participation in cotton picking than Arabs tribes.

**Table 5.17: Determinants of the total labour supply:**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficients</th>
<th>Standard errors</th>
<th>T-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>4.499</td>
<td>0.439</td>
<td>10.248***</td>
</tr>
<tr>
<td>Household size (log)</td>
<td>0.047</td>
<td>0.033</td>
<td>1.424</td>
</tr>
<tr>
<td>Tenant age (log)</td>
<td>0.108</td>
<td>0.134</td>
<td>0.806</td>
</tr>
<tr>
<td>Tenant education</td>
<td>-0.048</td>
<td>0.028</td>
<td>-1.714*</td>
</tr>
<tr>
<td>No. prime persons (log)</td>
<td>-0.167</td>
<td>0.064</td>
<td>-2.609*</td>
</tr>
<tr>
<td>No. elder persons (log)</td>
<td>-0.023</td>
<td>0.057</td>
<td>-0.404</td>
</tr>
<tr>
<td>Real wage rate (log)</td>
<td>0.426</td>
<td>0.261</td>
<td>1.632</td>
</tr>
<tr>
<td>Capital expenses (log)</td>
<td>0.942</td>
<td>0.176</td>
<td>5.352***</td>
</tr>
<tr>
<td>Total cultivated area (log)</td>
<td>0.226</td>
<td>0.031</td>
<td>7.290***</td>
</tr>
<tr>
<td>Real tenant income (log)</td>
<td>0.027</td>
<td>0.040</td>
<td>0.675</td>
</tr>
<tr>
<td>Distance from town, Km. (log)</td>
<td>-0.067</td>
<td>0.034</td>
<td>-1.971*</td>
</tr>
<tr>
<td>No. of days ill (log)</td>
<td>-0.001</td>
<td>0.038</td>
<td>-0.026</td>
</tr>
<tr>
<td>Sharecropping effect (dum.)</td>
<td>-0.062</td>
<td>0.027</td>
<td>-2.296*</td>
</tr>
<tr>
<td>Ethnical preference (dum.)</td>
<td>-0.041</td>
<td>0.021</td>
<td>-1.952*</td>
</tr>
</tbody>
</table>

F-value: 13.430 (0.000). $R^2 = 0.569$. $R^2 = 0.536$

*, ** and *** denotes significance at 10%, 5% and 1% levels respectively.

**Source:** Calculated from field survey, 2003/2004 season.

So it seems however, that the total labour supply in Gezira Scheme is primarily determined by economic, social and
demographic constraints, as well as to, some extent, the wage levels.

5.3 The determinants of income and wage rates: Empirical results and discussion:

5.3.1 The determinants of household off-farm income:

Ellis (2000) defines off-farm income as an income originating from wage labour on other farms, whereas Barrett et al (2001) refer to it as all activities away from the farmer’s own property. The last definition of off-farm income is the nearest description to this portion of farmer’s total income in Gezira Scheme. In this part of the study the determinants of off-farm income were specified using the so-called Tobit regression.

When conventional methods of regression fail to take into account the qualitative difference between zero and continuous observations, models such as logit, probit or Tobit will be used. Tobit models have been originally developed for censored data (Schwarze (2004). Tobit regression is special type of regression in which the dependent variable is truncated or censored above or below certain values, just as what we have in the data pertaining to the off-farm income in this study.

To estimate the determinants of off-farm incomes in Gezira Scheme, a Tobit model of the following form was used:

\[ Y = \beta X_i + e_i, \]

Where:

Y is the dependent variable taking the censored values as proportion of off-farm income in the total income.
B is a vector of parameters to be estimated. 

Xi vector of the factors that influence the household off-farm income, and 

e_i is the error term.

The explanatory variables expected to affect the household probability of having off-farm incomes were age, household size, the proportion of prime age household members, the proportion of the elderly persons in the household, the proportion of household members hiring out their labour, the proportion of the household members supplying labour on their farms, ownership of livestock (dummy), total cultivated area, having remittances or not (dummy), marital status (dummy), children below five years age (dummy) and three dummy variables for education levels.

Table (5.18) shows the result of this Tobit regression. It was indicated that age, the proportion of the elderly persons, livestock ownership, presence of remittances, marital status, children below five years, secondary and above secondary education was found to have statistically significant effect on households’ off-farm incomes. All these variables have the expected signs.
Table 5.18: Determinants of household off-farm income in Gezira Scheme

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficients</th>
<th>Standard error</th>
<th>T-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>1.449</td>
<td>0.169</td>
<td>7.574***</td>
</tr>
<tr>
<td>Tenant age, years</td>
<td>0.029</td>
<td>0.015</td>
<td>1.933*</td>
</tr>
<tr>
<td>Total cultivated area. feddan</td>
<td>0.048</td>
<td>0.047</td>
<td>1.021</td>
</tr>
<tr>
<td>Household size</td>
<td>0.005</td>
<td>0.129</td>
<td>0.0387</td>
</tr>
<tr>
<td>Proportion of prime persons per household</td>
<td>0.079</td>
<td>0.119</td>
<td>0.664</td>
</tr>
<tr>
<td>Proportion of elder persons per household</td>
<td>-0.074</td>
<td>0.041</td>
<td>-1.805*</td>
</tr>
<tr>
<td>Proportion of family labour supply</td>
<td>0.222</td>
<td>0.776</td>
<td>0.286</td>
</tr>
<tr>
<td>Proportion of family members having off-farm jobs</td>
<td>0.202</td>
<td>0.485</td>
<td>0.416</td>
</tr>
<tr>
<td>Livestock ownership (dummy)</td>
<td>1.622</td>
<td>0.645</td>
<td>2.515**</td>
</tr>
<tr>
<td>Having remittances or not (dummy)</td>
<td>0.249</td>
<td>0.137</td>
<td>1.818*</td>
</tr>
<tr>
<td>Marital status, (dummy)</td>
<td>1.389</td>
<td>0.708</td>
<td>1.962*</td>
</tr>
<tr>
<td>children below five years, (dummy)</td>
<td>-1.032</td>
<td>0.518</td>
<td>-1.993*</td>
</tr>
<tr>
<td>Primary education (dummy)</td>
<td>0.450</td>
<td>0.626</td>
<td>0.719</td>
</tr>
<tr>
<td>Secondary education (dummy)</td>
<td>0.626</td>
<td>0.361</td>
<td>1.734*</td>
</tr>
<tr>
<td>Above secondary education (dummy)</td>
<td>1.172</td>
<td>0.456</td>
<td>2.570**</td>
</tr>
</tbody>
</table>

Pseudo $R^2 = 0.7708$

Log likelihood function = -245.414

Source: Calculated from field survey 2003/2004 season.
5.3.2 The determinants of household total income:

The total household income is the sum of the net income from agricultural and non-agricultural self-employment and wage labour. In Gezira Scheme as mentioned in the descriptive analysis, about 56.1% of the total household income is obtained from agricultural activities, whereas the remaining proportion of the total income originates from non-agricultural sources. Based on that knowledge of the determinants and components of the total household incomes is essential for the design of policies related to promotion of alternative income strategies, this part of the study is an attempt to specify income determinants in Gezira Scheme. According to Schwarze (2004) the factors that influence the total income of the farm households could be classified as internal and external factors. The internal factors comprise the household resources, namely factors such as physical capital (i.e. land, livestock and other assets), human capital (i.e. education, age, dependency ratio) and social capital. The external factors involve the agro-ecological and socio-economics environment such as access to credit, availability of infrastructures and the like.

To specify the factors that may affect the total household income in Gezira scheme, the following linear regression model has been used:

\[ \log y = \beta x + e \]

Where:

Y denotes the total household income (in logarithmic form) and x the vector of variables influencing income. 
B is the vector of coefficients which will be estimated, and 
e is the error term.
Similar models on total household income have been widely used in the literature for example as in Janvry and Sadoulet (2001), Schwarze (2004). Table (5.19) presents the result pertaining to the factors that may influence the total incomes of tenants’ households in Gezira scheme. The model seems of good fit with the data as judged by the F-value and $R^2$. Among the household characteristics, the average number of elder persons per family, marital status of household head and the presence of children in the household are significant determinants in household total income. The significant negative effects of the number of elder persons and children below five years in the tenant household are expected, since their presence in the household implies dependency on household income rather than addition to it. The access to physical capital has significant influence on total household income. The total cultivated area, average total production, having remittances or not, supply of family labour, probability of off-farm jobs and livestock ownership positively influence total household income. The variable distance to nearest town is included in the model as a proxy for external factors that may affect total household income, but it turned out to be statistically not significant.
Table 5.19: Determinants of household total income in Gezira Scheme

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficients</th>
<th>Standard error</th>
<th>T-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>6.091</td>
<td>0.774</td>
<td>7.868***</td>
</tr>
<tr>
<td>Tenant age, years</td>
<td>0.002</td>
<td>0.002</td>
<td>0.958</td>
</tr>
<tr>
<td>Tenant education, years</td>
<td>0.002</td>
<td>0.006</td>
<td>0.372</td>
</tr>
<tr>
<td>Household size</td>
<td>0.004</td>
<td>0.015</td>
<td>0.272</td>
</tr>
<tr>
<td>Total cultivated land, feddan</td>
<td>0.464</td>
<td>0.239</td>
<td>1.941*</td>
</tr>
<tr>
<td>No. prime persons per household</td>
<td>0.004</td>
<td>0.013</td>
<td>0.292</td>
</tr>
<tr>
<td>No. elder persons per household</td>
<td>-0.040</td>
<td>0.022</td>
<td>-1.791*</td>
</tr>
<tr>
<td>Distance to nearest town</td>
<td>0.003</td>
<td>0.002</td>
<td>1.361</td>
</tr>
<tr>
<td>Average total production, kg</td>
<td>0.037</td>
<td>0.214</td>
<td>2.654**</td>
</tr>
<tr>
<td>Average output price, SD</td>
<td>0.003</td>
<td>0.010</td>
<td>0.267</td>
</tr>
<tr>
<td>Having remittances or not (dummy)</td>
<td>0.162</td>
<td>0.074</td>
<td>2.172**</td>
</tr>
<tr>
<td>Marital status, (dummy)</td>
<td>0.142</td>
<td>0.084</td>
<td>1.698*</td>
</tr>
<tr>
<td>Supply of family labour (dummy)</td>
<td>0.087</td>
<td>0.046</td>
<td>1.905*</td>
</tr>
<tr>
<td>Having off-farm job or not</td>
<td>0.076</td>
<td>0.043</td>
<td>1.781*</td>
</tr>
<tr>
<td>children below five years, (dummy)</td>
<td>-0.142</td>
<td>0.057</td>
<td>-2.504**</td>
</tr>
<tr>
<td>Livestock ownership (dummy)</td>
<td>0.138</td>
<td>0.070</td>
<td>1.980*</td>
</tr>
</tbody>
</table>

F-value: 5.200 (0.000). $R^2 = 0.614$. $R^{-2} = 0.579$

*, ** and *** denotes significance at 10%, 5% and 1% levels respectively.

Source: Calculated from field survey, 2003/2004 season.

5.3.3 The determinants of wage rates: Empirical results and discussion:

The Marxian theory of labour asserts that the value of labour power determines its price and that there are two elements in the value of labour power, the physical element and the historical or
social element. Success or failure in raising or lowering wages depends on the bargaining power of both the tenants and the workers. The bargaining power of both classes is determined by economic, political and ideological factors or, in other words by market relations, collective organization and class-consciousness. The economic factors (or market relations) are, in the main, the supply of and demand for different types of labour (Barnett and Abdelkarim, 1991). Since earnings incorporate labour supply decisions, wages are a better measure of labour productivity (Strauss and Thomas, 2001). Labour markets have not completely displaced nonmarket institutions for allocating labour such as extended households, communal work groups, and patron-client relationships. Wage labour transactions themselves are complex phenomena, embedded in broader patterns of social relations and conflict. The logic of supply and demand leaves undetermined many features of labour transactions (Kevane, 1994). However, the ILO Report (1976) asserted that wage rates in cotton picking in Gezira scheme are almost the same and appear to function almost like textbook models. Contrary to this O’Brien (1980) and Barnett and Abdelkarim (1991) observed the existence of wage differential in Gezira Scheme. The need may not be to state whether labour markets are competitive or not, but how they are competitive and how they coexist with nonmarket institutions (Squire, 1981; Kevane, 1994). Different nonmarket institutions coexist with markets even in the most advanced economies (Lin and Jeffrey, 2001).

Self employment wages depend on both preferences and production technology including prices of outputs and variable
inputs as well as quasi-fixed inputs (Strauss and Thomas, 2002). In the light of the surveyed review on wage determination in rural areas, the following log-linear regression model could be used to specify the factors that may affect the process of wage determination in Gezira Scheme:

\[ WAG = \beta_0 + \beta_1 \text{HHSIZ} + \beta_2 \text{AGE} + \beta_3 \text{EDU} + \beta_4 \text{AREA} + \beta_5 \text{PRP} + \beta_6 \text{ELDP} + \beta_7 \text{REXINP} + \beta_8 \text{ATPR} + \beta_9 \text{OUTPRIC} + \beta_{10} \text{RTINC} + \beta_{11} \text{DM}_1 + \beta_{11} \text{DM}_2 + \beta_{11} \text{DM}_3 + \beta_{11} \text{DM}_4 + e. \]

Where:

WAG = average deflated wage rate in real value for doing agricultural work in Gezira Scheme (season 2003/2004) in SD/man-day.

\( \beta_0 \) is the intercept, \( \beta_1 \) to \( \beta_{12} \) are parameters of explanatory variables.

HHSIZ = household size.

AGE = number of prime persons in the household.

ELDP = number of elder persons in the household.

EDU = education variable in total years of schooling.

AREA = average of total cultivated area, in feddans.

PRP = number of prime persons in the household.

ELDP = average number of elder persons in the household.

REXINP = average expenditure on variable inputs, S.D. per feddan.

ATPR = average total production per tenancy in kilograms.

OUTPRIC = average output price in SD per kilogram.

RTINC = average real tenant total income in SD.

DM1 = marital status (dummy variable).
DM2 = ethnical preference (dummy variable).
DM3 = probability of having off-farm job (dummy variable).
DM4 = presence of children below five years in the household (dummy variable).

Table (5.20) presents the result of the determinants of wages in Gezira Scheme in which for the dependent and the continuous independent variables the logarithm of the mean variables were used. As well, three independent variables were used in dummy forms. The model fits the data well as indicated by the statistics of the $R^2$ and the F-value. Wages in Gezira Scheme tends to be affected by factors related to household characteristics, demand side and supply side variables. Among the household characteristics, tenant age and household size positively affect wage determination, whereas, number of elder persons in the household and children below five years have negative effects. Education as a proxy for human capital turned to have positive significant impact on wage determination in Gezira Scheme. Average total cultivated land, average total production and average output price exerted a highly significant effect on wage determination. Also the variable ethnical preference as wage determinant has a highly significant negative effect.
Table 5.20: The determinants of wages in Gezira Scheme:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficients</th>
<th>Standard error</th>
<th>T-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.632</td>
<td>0.118</td>
<td>5.349***</td>
</tr>
<tr>
<td>Tenant age, years</td>
<td>0.160</td>
<td>0.045</td>
<td>3.587***</td>
</tr>
<tr>
<td>Tenant education, years</td>
<td>0.016</td>
<td>0.007</td>
<td>2.182**</td>
</tr>
<tr>
<td>Household size</td>
<td>0.042</td>
<td>0.021</td>
<td>1.963*</td>
</tr>
<tr>
<td>Total cultivated land, feddan</td>
<td>0.258</td>
<td>0.052</td>
<td>4.997***</td>
</tr>
<tr>
<td>No. prime persons per household</td>
<td>0.010</td>
<td>0.018</td>
<td>0.579</td>
</tr>
<tr>
<td>No. elder persons per household</td>
<td>-0.035</td>
<td>0.015</td>
<td>-2.351**</td>
</tr>
<tr>
<td>Average total expenditures on inputs, SD</td>
<td>0.005</td>
<td>0.039</td>
<td>0.132</td>
</tr>
<tr>
<td>Average total production, kg</td>
<td>0.080</td>
<td>0.028</td>
<td>2.904***</td>
</tr>
<tr>
<td>Average output price, SD</td>
<td>0.190</td>
<td>0.031</td>
<td>6.081***</td>
</tr>
<tr>
<td>Real tenant income, SD</td>
<td>0.015</td>
<td>0.010</td>
<td>1.578</td>
</tr>
<tr>
<td>Marital status, (dummy)</td>
<td>0.008</td>
<td>0.011</td>
<td>0.755</td>
</tr>
<tr>
<td>Ethnical preference, (dummy)</td>
<td>-0.017</td>
<td>0.005</td>
<td>-3.275***</td>
</tr>
<tr>
<td>Having off-farm job or not</td>
<td>-0.005</td>
<td>0.006</td>
<td>-0.795</td>
</tr>
<tr>
<td>Children below five years, (dummy)</td>
<td>-0.030</td>
<td>0.007</td>
<td>-4.439***</td>
</tr>
</tbody>
</table>

F-value: 10.406.254 (0.000). \( R^2 = 0.602 \). \( R^2 = 0.585 \)

*, ** and *** denotes significance at 10%, 5% and 1% levels respectively.

Source: Calculated from field survey, 2003/2004 season.
CHAPTER SIX

THE BEHAVIOURAL RESPONSES OF GEZIRA TENANTS: A FARM HOUSEHOLD MODELING APPROACH

In this chapter results and discussion of the farm household model are presented.

6.1 Model structure and estimation:

Probably no less than a quarter of the world population belongs to farm households, and most of this population is in the less developed countries (Ellis, 1993). Most households in agricultural areas produce partly for sale and partly for their own consumption. They also purchase some of their inputs and provide some from their own resources. Any change in the policies governing agricultural activities will therefore affect not only production but also consumption and labour supply (Singh, et al 1986).

Farm household models are often used to analyze household labour allocation in agriculture in developing countries (Sicular, 1986). Agricultural household models integrating a farm family’s production and consumption decisions into a unified theoretical framework have been widely applied for developing countries. In these models the demand equations are obtained from the maximization of a household utility function, which typically contains an agricultural commodity(ies), a market purchased good(s), and leisure, subject to cash income constraint containing farm profits, a time constraint and a farm production function.
(Narayanaasamy, 1997). Since these models incorporate both the consumption and production aspects, they capture the essential considerations underlying the allocation of family time between leisure and farm work. Moreover they provide a framework for understanding household participation in labour markets as suppliers of family labour or as employers of hired labour (Sicular, 1986).

Behaviour under perfect markets implies separability between production and consumption decisions (Singh et al, 1986). By contrast, production and consumption decisions are non-separable when there are market failures. In this case, variables that affect consumption decisions also affect production decisions. Thus correct modeling of household production decisions requires knowledge of whether a specific household is likely to behave according to separability or non-separability decision rules (Vakis et al, 2004).

A combination of economic theory and empirical evidence suggests that an accurate simulation of the impact of non-marginal changes in exogenous conditions on household behaviour requires the specification of a non-separable household model that allows for the interdependence of utility and profit maximizing decisions (Abiassi, 2002). In this study the model used is meant to be a first attempt in constructing a flexible tool for evaluating the impact of policy changes on crops production, labour allocation and consumption of own produce and market purchased goods in Gezira scheme. It is a relatively simple non-separable household model in which a combination of production functions and utility
function analysis were utilized to simulate the impact of different policy scenarios on Gezira tenants.

6.2 Non-separability in farm household models:

To provide an empirical evidence for the selection of the non-separable form of the household model, it was important to assess the acceptance of the separability assumptions in the light of the available evidence from the study area. Critically, this may include the nature of product and labour markets in Gezira scheme.

The farm households in Gezira Scheme are characterized by differentiation in their asset positions which may influence their labour supply and their demand for farm labour. Also, as could be seen from the collected data regarding the wage rates that there are so many complications and complexity in wage rates and this may lead to a divergence between wages received when selling labour and wages received when hiring labour. Those two features may imply that the farm households in the study area are differentially integrated into labour markets, with some selling labour services, others hiring labour and others opting for labour self-sufficiency. Thus, if some of the households are self-sufficient in labour, production and consumption decisions are linked through the time constraint, and the two problems must be solved simultaneously (Abiassi, 2002). According to a fully separable model, the decision about on-farm labour allocation should be purely a production decision, and thus household characteristics should not affect it (Vakis et al, 2004). However, it was observed from the regression analysis carried in this study that the socio-economic context of the farm households is very significant in shaping their labour
demand and supply situations. Consequently to model such households, the production side can not be estimated independently from the consumption side, and hence the model should be non-separable rather than separable. Econometric evidence is accumulating in support of household models that are non-separable because of issues related to labour and demographic characteristics (Abiassi, 2002). Lopez (1984) with Canadian data set rejected the separability as a result of imperfect substitutability between on- and off-farm works. Benjamin (1992) found that, for a Javanese data set, demographic variables influence the production decisions, which is incompatible with a recursive model. Jacoby (1993) and Skoufias (1994) have rejected the hypothesis that the household shadow wage equals the market wage, for Indian and Peruvian households respectively, an outcome that requires a non-separable model.

Regarding the product markets, they exist and the households mostly participate both as buyers and sellers, but there are several complicating factors. For instance, the prices of agricultural products differ significantly for the same product so that the price paid to farmers for their output is much lower than that paid later in the year when their supply was depleted. This may render the farm households to be self-sufficient producing all their needed food products, which will add to the invalidity of the assumption of indifference between home-produced and purchased goods.

Thus in this study the emphasis is to specify a non-separable version of the farm household model because this non-separability implies that a change in any of the exogenous variables affecting
the production choices of the household will also influence the labour supply, the factor demand, the marketed surplus, the household income and consumption.

6.3 Model structure and the basic assumptions:

The household model used in this study is a combination of two main interrelated parts: the production part and the consumption part. The production part involves a detailed analysis of the agricultural production of the four major field crops in Gezira scheme. The Cobb-Douglas form of the production function is adopted as previously explained in this chapter. The consumption part of the model investigates changes in farm household consumption behaviour due to changes in revenues and prices. Consumer behaviour is represented by the Cobb-Douglas form of utility function. Cobb-Douglas utility function yields very simple demand functions, which are homogenous of degree zero and have been widely used in economic literature (Narayanaasamy, 1997). The model was solved using non-linear programming in two stages. First, the production functions of farm produced outputs are estimated. Then utility is maximized subject to the production functions, budget constraint, time and factor endowment constraints. In this study, utility is a function of the consumption desires of farm produced wheat and sorghum outputs, the consumption of market purchased goods and leisure component.

This model provides a framework for generating predictions about the responses of the farm household to changes in labour supply, market output prices and wage rates variables. Based on
Barnum and Squire (1979) farm household model, the main assumptions of this model are as follow:

- Product prices and wages are taken exogenously by the household and markets are assumed to be perfectly competitive.
- There exists a market for labour so that farm households are able to hire in and hire out labour at a given market wage.
- Land available to the farm household is fixed at least for the production cycle under study.
- Home activity (production of Z-goods) and leisure are combined and treated as the same consumption item for the purpose of utility maximization.
- Uncertainty and behaviour towards risk are ignored.

6.4 Overview of the model equations:

A more primary objective of the tenants’ households in Gezira scheme is the provision of food. They first allocate their resources to assure necessary food supplies, and then the remaining resources are used to generate cash income. Another important consideration for these households is a desire to enjoy more leisure. So the consumption of food commodities and leisure by a farm household along with consumption of market purchased goods are incorporated in the utility function.

The utility function is:

\[ U = f (T, C, M) \]

Where:

- \( T \) is total available time,
- \( C \) is home consumption of output, and
M is the consumption of purchased goods.

Utility is maximized subject to a production function, time and income constraints. The Production function is:

\[ Y = f (A, L, V) \]

Where:
- \( Y \) is the output produced per tenancy,
- \( A \) is the land under cultivation,
- \( L \) is the total labour used in production, and
- \( V \) is the other variable inputs into production.

The time constraint is of the form:

\[ T = T_1 + T_f + T_w \]

Where:
- \( T_1 \) is the time allocated to home activities and leisure,
- \( T_f \) is the time allocated to farm work, and
- \( T_w \) is wage work which may be positive if labour is hired-in and negative if labour is hired-out.

The income constraint states that net household earnings should equal expenditure on market goods:

\[ P (Q - C) + wT_w - vV = mM \]

Where:
- \( P \) is the output price,
- \( (Q - C) \) is the quantity of total output sold rather than consumed,
- \( w \) is the market wage,
- \( wT_w \) may either represent an addition to income (if labour is hired out) or a subtraction (if labour is hired in),
v is the price of variable input, and
m is the average price of market purchased goods M.

The equilibrium conditions of this model follow the standard micro-economic results of production and consumption, that is the marginal product of labour should equal the wage rate, the marginal product of other variable inputs should equal their average price, the marginal rate of substitution between home time and purchased goods should equal their price ratio and that the marginal rate of substitution between home consumption and purchased goods should also equal their price ratio.

6.5 Model constraints:

As it was noted above, the utility function is maximized subject to goods constraint, time constraint, land constraint and an income constraint. The production function component is included in goods constraint and is explained earlier in chapter five. For the income constraint, it is assumed that the net income derived from the sale of cash crops plus income from other sources form the left hand side of the money balance equation. On the right hand side of the equation, the expenditure side comprises purchases of market goods and variable inputs. The income constraint states that the surplus production over home consumption along with other income sources is sold to the market and the resulting income is utilized to purchase non-agricultural market goods, inputs and to complement the leisure available to the farm households.

According to the time constraint, the total available farm household labour is allocated to the farm work in the scheme apart from leisure and off-farm labour for wages. Thus, labour supply is
included as a major factor influencing consumption of the farm households.

The goods constraint states that total crop output is equal to the sum of own consumption and marketed surplus of that produce. The land or factor endowment constraint deals with the allocation of land among different uses. Land is one of the most important constraints that could not be increased in the short run.

6.6 Utility function specification:

The basic goal of the analysis is to find measures of consumption desires of time, consumed output and consumed purchased goods which facilitate the development of empirical implications.

The consumer is assumed to choose among the available competing items in such a manner that the satisfaction (utility) is as large as possible. The consumer household selects the most preferred bundle of commodities from a set of alternatives and the utility function represents only the preference ordering.

If we suppose that the consumer’s preference can be represented by the utility function as in the following equation:

\[ U = f (x_1, x_2, x_3) \]

Then the marginal utility of \( x_i \) is equal to:

\[ \frac{\partial U}{\partial x_i} = \frac{\partial U}{x_i} \] (1)

And the elasticity of consumption of a commodity \( x_i \) is:

\[ \epsilon = \frac{\partial U/\partial x_i * x_i}{U} \]

At equilibrium point, the marginal utility derived from consumption of any commodity is equal to the price ratio as shown below:
\[ \frac{\partial U}{\partial x_i} = \frac{P_{xi1}}{P_{xi2}}. \quad (2) \]

Where:

\( X_i \) = commodities represented in the consumption bundle of farm household.

\( P_{xi} \) = prices of \( x_i \).

\( \epsilon \) = elasticity.

\( U \) = utility.

So by solving equations (1) and (2), we get the following relation:

\[ \epsilon \frac{U}{x_i} = \frac{P_{xi1}}{P_{xi2}}. \]

\[ \epsilon = \frac{P_{xi1} \cdot x_i}{U \cdot P_{xi2}}. \quad (3) \]

Utility is an index without dimension. Here it is taken as \( I_u = \sum x_i P_{xi} \), where \( I_u \) is the utility index. The parameters of the Cobb-Douglas utility function are derived by considering the share of expenditure on each of the commodity bundles and the function is a homogenous function of degree one:

\[ \epsilon = \frac{x_i P_{xi}}{\sum x_i P_{xi}} \quad (4) \]

The existing consumption of food crops, namely wheat and sorghum, and market purchased goods and their respective prices are given in table (6.1). The opportunity cost of leisure is evaluated at the existing market wage for man equivalent days and the commodities in the consumption bundle are evaluated at market prices. The derived utility function using equation (4) is as follows:

\[ U = x_1^{0.1739} x_2^{0.2019} m^{0.3873} l^{0.2368}. \]

Where:

\( X1 \) = consumption of own agricultural produce wheat.
\( X2 = \) consumption of own agricultural produce sorghum.
\( m = \) consumption of purchased goods.
\( l = \) consumption of leisure.

**Table 6.1:** Consumption levels of agricultural and market purchased goods by the farm households in Gezira Scheme:

<table>
<thead>
<tr>
<th>Commodities</th>
<th>Quantities</th>
<th>Prices</th>
<th>Elasticities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>1389.3</td>
<td>55.2</td>
<td>0.1739</td>
</tr>
<tr>
<td>Sorghum</td>
<td>2131.3</td>
<td>41.8</td>
<td>0.2019</td>
</tr>
<tr>
<td><strong>Market purchased goods</strong></td>
<td>170827.9</td>
<td>1.0</td>
<td>0.3873</td>
</tr>
<tr>
<td>Leisure</td>
<td>149</td>
<td>701.0</td>
<td>0.2368</td>
</tr>
</tbody>
</table>

**Source:** Calculated from field survey, 2003/2004 season.

**6.7 Scenarios for analysis:**

In this study the simulation analysis examines the impact, as well as providing details on how the Gezira tenants may be affected by different policy variables. The non-linear programming model was run for six scenarios, namely a 20% increase in labour supply, a 20% decrease in labour supply, a 50% increase in wage rates, a 50% increase in the prices of cash crops, a combination of 50% increase in labour wages and 50% increase in the prices of cash crops and finally a 30% increase of the absolute term in the production function to resemble an increase in total production due to some improvements in production techniques.
6.8 Model results and discussion:

The modeling done in this study forecasts the effects of different policy measures on production of field crops, consumption of food crops and labour allocation by the farm households in Gezira Scheme. The results of the analysis, though pertained to only a sample of Gezira Scheme population, may be adequate in providing rough guidelines for some required policy actions by policy makers in the irrigated sector of Sudan agriculture.

7.8.1 Baseline results and the existing condition:

The basic solution results are listed in tables (6.2, 6.3, 6.4 and 6.5). The existing condition is a starting point for a small farm household and base solution results reflect that the farm household is trying to allocate their limited resources in a rational way. In total, the obtained results in the base solution are reflecting the main characteristics of the observed farming conditions if not all of them in the study area. Regarding the output of the studied crops, it may nearly reflect the existing farming conditions except for wheat. This crop, although is a food crop, but it is not like sorghum, the staple food crop in Gezira area. The tenants mentioned that a major part of its output is taken by SGB as cost of production (field survey, 2003/2004). On the other hand, it seems however, that a lot of resources were devoted to the production of cotton crop, especially in case of land resource.
Table 6.2: Existing and base solution values of cotton production variables

<table>
<thead>
<tr>
<th>Item</th>
<th>Existing condition</th>
<th>Base solution results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton output (Kgs)</td>
<td>2116.1</td>
<td>1682.9</td>
</tr>
<tr>
<td>Labour per farm (mandays)</td>
<td>227.9</td>
<td>340.8</td>
</tr>
<tr>
<td>Area (feddans)</td>
<td>3.6</td>
<td>10.9</td>
</tr>
<tr>
<td>Variable inputs (SD)</td>
<td>55128.1</td>
<td>68778.4</td>
</tr>
</tbody>
</table>

Source: Calculated from field survey data and model results.

Table 6.3: Existing and base solution values of wheat production variables

<table>
<thead>
<tr>
<th>Item</th>
<th>Existing condition</th>
<th>Base solution results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat output (Kgs)</td>
<td>2563.1</td>
<td>207.4</td>
</tr>
<tr>
<td>Labour per farm (mandays)</td>
<td>31.8</td>
<td>31.4</td>
</tr>
<tr>
<td>Area (feddans)</td>
<td>3.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Variable inputs (SD)</td>
<td>36662.8</td>
<td>36368.5</td>
</tr>
</tbody>
</table>

Source: Calculated from field survey data and model results.
Table 6.4: Existing and base solution values of Sorghum production variables

<table>
<thead>
<tr>
<th>Item</th>
<th>Existing condition</th>
<th>Base solution results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sorghum output (Kgs)</td>
<td>2575.5</td>
<td>1087.5</td>
</tr>
<tr>
<td>Labour per farm (mandays)</td>
<td>94.9</td>
<td>67.3</td>
</tr>
<tr>
<td>Area (feddans)</td>
<td>3.7</td>
<td>2.7</td>
</tr>
<tr>
<td>Variable inputs (SD)</td>
<td>26695.1</td>
<td>22538.4</td>
</tr>
</tbody>
</table>

Source: Calculated from field survey data and model results.

Table 6.5: Existing and base solution values of groundnut production variables

<table>
<thead>
<tr>
<th>Item</th>
<th>Existing condition</th>
<th>Base solution results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundnut output (Kgs)</td>
<td>1590.4</td>
<td>1942.3</td>
</tr>
<tr>
<td>Labour per farm (mandays)</td>
<td>154.9</td>
<td>113.8</td>
</tr>
<tr>
<td>Area (feddans)</td>
<td>3.5</td>
<td>1.9</td>
</tr>
<tr>
<td>Variable inputs (SD)</td>
<td>26787.7</td>
<td>37188.9</td>
</tr>
</tbody>
</table>

Source: Calculated from field survey data and model results.

6.8.2 Impacts of various policy scenarios on production and consumption of Gezira tenants:

From an economic and technical point of view, no single policy option could have a consequential impact on production and productivity of resources. Hence, combinations of different policy
scenarios are simulated and simulation results are presented in comparison with the baseline scenario. Table (6.6) presents the results of the different suggested changes in policy variables. As shown in the table and compared to the baseline result, the increase in labour supply (scenario 1) affects increasingly the production of crops, the consumption and marketed surplus for all crops except for groundnut. This result may be in line with the field study result concerning the sharecropping practice. However, in scenario two, where labour supply is suggested to decrease by 20%, reflects a decrease in production, consumption and marketed surplus for all crops except for groundnut. This may confirm the result in scenario one. Under the increase in labour wage rates by 50% (scenario 3) there are no changes in amounts of production, consumption and marketed surplus compared to the baseline result. Under the increase in the prices of cash crops (scenario 4), production, consumption and marketed surplus are increased for all crops except for cotton. However, the same result is obtained in scenario five where the suggested policy is a combination of 50% increase in wages and output prices. This may imply that the increase in wage rates has no effect on production, consumption and marketed surplus as could be seen in scenario three result. Under the increase in agricultural productivity (scenario 6), there are marked increases in production, consumption and marketed surplus for all crops compared to the results of baseline solution.
Table 6.6: Simulated production, consumption and marketed surplus of field crops in Gezira Scheme under the suggested policy scenarios in absolute values:

<table>
<thead>
<tr>
<th>Crops and activities</th>
<th>Base line</th>
<th>Scenarios</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td><strong>Production</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cotton</td>
<td>1682.9</td>
<td>1902.7 1432.9 1682.9 1549.7 1549.7</td>
</tr>
<tr>
<td>Wheat</td>
<td>207.4</td>
<td>221.3 190.7 207.4 234.7 234.7</td>
</tr>
<tr>
<td>Sorghum</td>
<td>1087.5</td>
<td>1207.6 950.6 1087.5 1274.4 1274.4</td>
</tr>
<tr>
<td>Groundnut</td>
<td>1942.3</td>
<td>1818.4 2098.2 1942.3 1971.4 1971.4</td>
</tr>
<tr>
<td><strong>Consumption</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cotton</td>
<td>-</td>
<td>- - - - - - - - -</td>
</tr>
<tr>
<td>Wheat</td>
<td>207.4</td>
<td>221.3 190.7 207.4 234.7 234.7</td>
</tr>
<tr>
<td>Sorghum</td>
<td>1087.5</td>
<td>1207.6 950.6 1087.5 1274.4 1274.4</td>
</tr>
<tr>
<td>Groundnut</td>
<td>-</td>
<td>- - - - - - - - -</td>
</tr>
<tr>
<td><strong>Marketed surplus</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cotton</td>
<td>1682.9</td>
<td>1902.7 1432.9 1682.9 1549.7 1549.7</td>
</tr>
<tr>
<td>Wheat</td>
<td>-</td>
<td>- - - - - - - - -</td>
</tr>
<tr>
<td>Sorghum</td>
<td>-</td>
<td>- - - - - - - - -</td>
</tr>
<tr>
<td>Groundnut</td>
<td>1942.3</td>
<td>1818.4 2098.2 1942.3 1971.4 1971.4</td>
</tr>
</tbody>
</table>

Source: Model results.

However, table (6.7) shows the possible changes due to the suggested policies in different scenarios in percentage terms considering the base line result as 100.0%.
Table 6.7: Simulated production, consumption and marketed surplus of field crops in Gezira Scheme under the suggested policy scenarios in percentage terms:

<table>
<thead>
<tr>
<th>Crops and activities</th>
<th>Base line</th>
<th>Scenarios</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td><strong>Production</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cotton</td>
<td>100.0</td>
<td>113.1</td>
</tr>
<tr>
<td>Wheat</td>
<td>100.0</td>
<td>106.7</td>
</tr>
<tr>
<td>Sorghum</td>
<td>100.0</td>
<td>111.0</td>
</tr>
<tr>
<td>Groundnut</td>
<td>100.0</td>
<td>93.6</td>
</tr>
<tr>
<td><strong>Consumption</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cotton</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Wheat</td>
<td>100.0</td>
<td>106.7</td>
</tr>
<tr>
<td>Sorghum</td>
<td>100.0</td>
<td>111.0</td>
</tr>
<tr>
<td>Groundnut</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Marketed surplus</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cotton</td>
<td>100.0</td>
<td>113.1</td>
</tr>
<tr>
<td>Wheat</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sorghum</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Groundnut</td>
<td>100.0</td>
<td>93.6</td>
</tr>
</tbody>
</table>

Source: Model results.

6.8.3 Impacts on inputs usage:

Compared to the baseline result, increases in labour supply (scenario 1) may lead to increase in labour use on farms for the production of field crops. In percentage terms, the effect is an increase of 24.4%, 24.5%, 24.5% and 2.9% in labour use for the production of cotton, wheat, sorghum and groundnut respectively. Regarding land resource, there are slight differences in its
allocation between crops compared to the baseline result. The result also showed an increase of 4.6%, 2.1%, 4.8% and 5.4% in the use of variable inputs for the production of cotton, wheat, sorghum and groundnut respectively. Generally, it looks as if with an increase in labour supply, farmers tend to allocate more resources for the production of cash crops. However, under the decrease in labour supply (scenario 2) the allocation of resources, namely labour, land and variable inputs is decreasingly affected compared to the baseline result. In scenario 3, where wages were supposed to increase by 50%, no effect is observed on resource usage. Under the increase in the prices of cash crops (scenario 4), compared to the baseline result, the allocation of resources is increasingly affected except in case of cotton crop. This result for cotton is not surprising in the context of Gezira Scheme where cotton is a government crop and the farmer has no role in its marketing. In scenario five which is a combination of increases in wages and cash crop prices, the result is the same as that in scenario 4. This result implies that increase in wages has no effect on inputs usage and this is may be due to that a considerable part of the total available labour is of family source that is usually valued at the market wage of hired labour. Regarding the last scenario where the suggested policy is an increase in production due to the practice of some technological packages, there are also increases in input uses for all crops (table, 6.8). Taking the result of the base solution as equivalent to 100.0%, the possible changes in the six suggested scenarios are shown on table (6.7) in percentage terms.
Table 6.8: Simulated impacts on inputs usage under various policy scenarios

<table>
<thead>
<tr>
<th>Crops and inputs</th>
<th>Base line</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cotton</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labour</td>
<td>340.8</td>
<td>423.9</td>
<td>258.3</td>
<td>340.8</td>
<td>319</td>
<td>319</td>
<td>345.3</td>
</tr>
<tr>
<td>Land</td>
<td>10.9</td>
<td>11.1</td>
<td>10.6</td>
<td>10.9</td>
<td>10</td>
<td>10</td>
<td>10.7</td>
</tr>
<tr>
<td>Variable inputs</td>
<td>68778.4</td>
<td>71914.9</td>
<td>64313.4</td>
<td>68778.4</td>
<td>62642.7</td>
<td>62642.7</td>
<td>68996.7</td>
</tr>
<tr>
<td>Wheat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labour</td>
<td>31.4</td>
<td>39.1</td>
<td>23.8</td>
<td>31.4</td>
<td>37.2</td>
<td>37.2</td>
<td>32.7</td>
</tr>
<tr>
<td>Land</td>
<td>2.5</td>
<td>2.5</td>
<td>2.4</td>
<td>2.5</td>
<td>2.9</td>
<td>2.9</td>
<td>2.6</td>
</tr>
<tr>
<td>Variable inputs</td>
<td>36368.5</td>
<td>37148.4</td>
<td>25331.2</td>
<td>36368.5</td>
<td>38896.0</td>
<td>28896.0</td>
<td>26950.8</td>
</tr>
<tr>
<td>Sorghum</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labour</td>
<td>67.3</td>
<td>83.8</td>
<td>51.1</td>
<td>67.3</td>
<td>79.8</td>
<td>79.8</td>
<td>70.1</td>
</tr>
<tr>
<td>Land</td>
<td>2.7</td>
<td>2.8</td>
<td>2.7</td>
<td>2.7</td>
<td>3.2</td>
<td>3.2</td>
<td>2.8</td>
</tr>
<tr>
<td>Variable inputs</td>
<td>22538.4</td>
<td>23612.2</td>
<td>21109.9</td>
<td>22538.4</td>
<td>26019.0</td>
<td>26019.0</td>
<td>23340.1</td>
</tr>
<tr>
<td>Groundnut</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labour</td>
<td>113.8</td>
<td>117.1</td>
<td>109.4</td>
<td>113.8</td>
<td>117.3</td>
<td>117.3</td>
<td>115.1</td>
</tr>
<tr>
<td>Land</td>
<td>2.0</td>
<td>1.6</td>
<td>2.3</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Variable inputs</td>
<td>37188.9</td>
<td>39198.7</td>
<td>35310.7</td>
<td>37188.9</td>
<td>37316.1</td>
<td>37316.1</td>
<td>37386.6</td>
</tr>
</tbody>
</table>

Source: Model results.
The impact of the various policy scenarios on the factors of production can be analyzed through shadow prices of factors. In economic theory, the price the farmer is willing to pay to use an additional unit of each resource is the marginal value product. In mathematical programming these values are called shadow prices. The marginal utilities are given by the model and shadow prices are derived as shown below:
\( \frac{\partial U}{\partial X} \) is the marginal utility of the \( x \) resource.

\( \frac{\partial U}{\partial M} \) is the marginal utility of money.

So the marginal utility of the resource in question could be expressed of in monetary terms by relating it to the marginal utility of money:

\[
\frac{\partial U}{\partial X} / \frac{\partial U}{\partial M} = \frac{\partial M}{\partial X},
\]

which gives the marginal utility in value terms or what is called shadow price. The marginal utility of factors is listed in table (6.10) and the factor shadow prices are listed in table (6.11).

The equilibrium conditions of this model, according to Barnum and Squire (1979) and Ellis (1992), follow the standard microeconomic results for production and consumption. The part of these conditions with regard to the use of factors of production is as follow:

- The marginal value product of labour (MVPL) should equal the market wage rate (\( w \)).

- The marginal value product of other variable inputs (MVPv) should equal their average price (\( v \)).

Since the growth in the stock of traditional inputs, namely land, labour and capital, remains the dominant source of output growth in Sub-Saharan Africa and modern inputs (i.e. fertilizers, tractors) were next in importance in terms of contribution to output growth (Frisvold and Ingram, 1995). Therefore the emphasis in this study will be on these inputs. For land input, it seems that the use of it creates higher units of utility to the farm households and hence higher shadow prices were incurred when valued in
monetary units (tables 6.10 and 6.11). Similar results were obtained in the context of Indian farm households by Narayanaasamy, (1997). Since in Sudan there is no land market as such, the discussion of its shadow prices will not be elaborated. Regarding the factor of variable inputs which is used in this study as a proxy for capital, lower units of utility and lower values of shadow prices were obtained compared to other factors (tables 6.10 and 6.11). For capital the marginal profit levied by commercial Banks in Murabaha is on average about 18%, thus following Heady and Dillon (1961) the market price of capital is DS 1.18 (DS 1.00 principal plus 18%). So from the result in table (6.11) in all scenarios the shadow price of capital is below one except in scenarios four and five. It seems a logical result since the suggested policies in these scenarios were a 50% increase in output price of cash crops (scenario 4) and a combination of 50% increase in output prices and wage rates (scenario 5), that is there are incentives to farmers to invest more on capital inputs.
Table 6.10: The marginal utility of factors under the suggested policy scenarios:

<table>
<thead>
<tr>
<th>Factors</th>
<th>Base line</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land</td>
<td>54.01</td>
<td>59.144</td>
<td>42.046</td>
<td>49.065</td>
<td>69.381</td>
<td>63.030</td>
<td>58.429</td>
</tr>
<tr>
<td>Variable inputs</td>
<td>0.003</td>
<td>0.001</td>
<td>0.003</td>
<td>0.003</td>
<td>0.005</td>
<td>0.004</td>
<td>0.001</td>
</tr>
<tr>
<td>Money</td>
<td>0.009</td>
<td>0.009</td>
<td>0.010</td>
<td>0.009</td>
<td>0.008</td>
<td>0.007</td>
<td>0.009</td>
</tr>
</tbody>
</table>

Source: Model results.

Since the main objective of this study is to answer some questions in the context of agricultural labour markets in Sudan, the results pertained to this variable will be detailed in discussion. It is clear from the tables (6.10 and 6.11) that the marginal utilities and shadow prices of labour are nearly the same in the base line results and in all scenarios, except that in scenario three and five. The suggested policy in scenario three in a 50% increase in wage rates, thus when comparing the shadow price in this scenario with the existing market wage of labour of DS 701.0 (field survey, 2003/2004), it seems nearly the same. This may imply that the farm households in the study area maximize their marginal value inputs to the optimal values under the open market conditions (Narayanaasamy, 1997). When considering the shadow price in the base line result (DS 383.8) which is obtained pricing the labour in the model at the market wage rate (DS 701.0) this may imply that labour were paid lower prices than the ruling market wages. However these shadow prices of labour were above zero and
positive contrary to the common belief about the developing countries that labour were in abundant supply of zero marginal productivity. Nevertheless, the implications of lower shadow wage than the ruling market wage is a symptom of labour market failure or inefficiency in its operation. This may confirm the results obtained by the use of Cobb-Douglass analysis previously discussed in this chapter. It is also in line with so many studies done in the context of the developing countries and Africa.

On the other hand, under the increase in labour supply (scenario 1), the shadow wage is increased compared to the baseline result, while it is decreased under the decrease in labour supply (scenario 2). Thus this may imply a wage response to changes in labour supply which confirm the existence of active labour market. But hence output price and an increase in output production both comprise a labour demand-side variables and both have a positive effect on wages, their effects on shadow wage of labour as shown on table (6.11) is negative compared to the baseline result. So it is impracticable to conclude that the labour market in the study area operates according to the competitive view.
Table 6.11: Factor shadow prices under the suggested policy scenarios

<table>
<thead>
<tr>
<th>Factors</th>
<th>Base line</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour</td>
<td>389.3</td>
<td>415</td>
<td>354.3</td>
<td>689.2</td>
<td>214.5</td>
<td>591.3</td>
<td>361.4</td>
</tr>
<tr>
<td>Land</td>
<td>600.1</td>
<td>6571.6</td>
<td>4204.6</td>
<td>5451.7</td>
<td>8672.6</td>
<td>9004.3</td>
<td>6492.1</td>
</tr>
<tr>
<td>Variable inputs</td>
<td>0.333</td>
<td>0.111</td>
<td>0.30</td>
<td>0.333</td>
<td>0.625</td>
<td>0.571</td>
<td>0.111</td>
</tr>
</tbody>
</table>

Source: Calculated from model results.

6.9 Limitations of the model:

The farm household model developed in this study presents some limitations which are mainly related to the simplifying assumptions of the model. The most important points are the following:

- The assumption of a single household utility function.
- The assumption of no risk.
- The static nature of the model i.e. not incorporating technological changes, credit constraints and the like.

Despite these limitations, the model attempts to realize some of the farm household decisions about production, consumption and usage of factors of production.
CHAPTER SEVEN
SUMMARY, CONCLUSIONS
AND RECOMMENDATIONS

7.1 Summary:

The study depends mainly on primary data which have been collected by means of structured questionnaire and direct interviewing with the Gezira tenants who grew cotton, wheat, sorghum and groundnut crops for the season 2003/2004. Also necessary secondary data have been used. A multi-stage stratified random sample of 150 respondents was selected. As well a sample of 60 respondents was selected from the hired workers in Gezira Scheme. The analytical techniques used to test for the study hypotheses are; descriptive statistics, the Cobb-Douglas production function analysis, other econometric analysis such as multiple and Tobit regressions. Then, based on household theory, a quantitative farm household model was developed using non-linear programming.

The descriptive analysis showed that the farmers are homogenous group with respect to the level of education and the majority of them were within the productive age group. The average family size of 7.6 persons per household was indicative of large potential labour force. The average farm income was in the low range of income levels, with little or no saving for agricultural investment. The average yield of cotton, wheat, sorghum and groundnut was estimated as 630.5, 732.3, 701.0 and 472.1 kilograms per feddan respectively. These yield levels though they
were low, they were confirmed to some extent by the result of the Planning and Socio-economic research Unit of the Sudan Gezira Board.

With regard to the sample of the agricultural workers (landless workers), their average age was estimated as young as 45.4 years and regarding their source they could be either seasonal, local or labour from camps. Ethnically the seasonal and local workers were from the Arabian tribes, whereas, the camp workers were from the West African tribes who early migrated to the scheme.

The use of the Cobb-Douglas technique is for the analysis of the output response to labour input, human capital and farm production characteristics and for testing the efficiency of the labour market in Gezira scheme. Two sets of equations were specified, one for the average total of labour and the other for family and hired labour as separate explanatory variables.

The result of the estimated Cobb-Douglas function for the crops in question showed that they were estimated with good explanatory power. The result indicated that total labour, average cost of variable inputs, age, education and harvesting date are significant in explaining the variation in cotton yield. For the wheat crop, the significant factors are cultivated area, total labour, average cost of variable inputs and number of irrigations. For sorghum crop, they are cultivated area, total labour, average cost of variable inputs and number of irrigations, while for groundnut crop, the significant factors are total labour, average cost of variable inputs, sowing date and harvesting date. It was also found that when the variable of total labour is used as family and hired
categories in another set of equations, both family and hired labour were significantly important in explaining the output variation for all studied crops. However the assessment of the labour market efficiency revealed that the shadow wages were significantly deviated from their market wage.

With regard to the determinants of labour supply and demand, log-linear multiple regression was used to specify these determinants. The results showed that supply and demand were affected by factors related to the household characteristics, economic and non-economic variables. Also wage and household incomes were examined using multiple and Tobit regressions. The econometric results showed that household wage and incomes were mostly affected by some variables related to human and physical capital beside some of the household socio-economic characteristics.

The purpose of building the farm household model is to provide a simplest possible general equilibrium model for the farming conditions in Gezira Scheme. So this may necessarily need making simplifying assumptions. The model was developed to simulate the effects of some expected policy reforms on the farming conditions in the study area. The model results depend not only on the parameter values used but also on the assumptions underlying the model. As it is clear when moving from one scenario to another, one may guess that relatively simple policies can be designed to improve the existing farming conditions. Generally, some of these policies may lead to increase in production, consumption and marketed surplus of the farm households (scenario one and six) and other policies may lead to
an opposite effect (scenario two and four) with some exceptional cases between crops. The same could be said on input usage. Regarding the shadow prices of inputs, namely labour, they were found to improve compared to the market prices under policies such as increasing inputs (labour) and output prices (cash crops). The comparison of the shadow wage of labour with the market wage revealed that returns to labour are very low especially when compared with returns from other non-agricultural industries. Also this result may imply that the allocation of resources, namely labour, beside market variables is affected by other non-market variables.

7.2 Conclusions:

The main findings of this study could be summarized in the following points:

- As shown in the descriptive analysis of the Gezira tenants the family labour has low participation rate in agricultural work.

- Among the studied crops, cotton is labour intensive crop, followed by groundnut, then sorghum and wheat crops.

- The analysis of the socio-economic characteristics of the agricultural workers revealed that the early settled migratory workers prefer to work as sharecroppers with the tenants than to work as hired labourers.

- The descriptive analysis of wage rates in Gezira scheme showed a very complicated nature of these wages and how they were varied among crops and types of workers.
• The descriptive analysis of some related aspects to the rural labour markets in Gezira Scheme assured the existence of some non-market institutions such as sharecropping practices. Also it was observed that the interviewed tenants tried to diversify their income sources and there were some reported cases of internal and external migration among the tenants’ households.

• From the production function analysis, it could be argued that, total labour, average cost of variable inputs, age, education and harvesting date are the main factors determining the variation in cotton yield. For the wheat crop, these factors are cultivated area, total labour, average cost of variable inputs and number of irrigations. For sorghum crop, they are cultivated area, total labour, average cost of variable inputs and number of irrigations, while for groundnut crop, the significant factors are total labour, average cost of variable inputs, sowing date and harvesting date.

• The test of the efficiency of the rural labour market in Gezira Scheme demonstrated that markets do not behave as predicted by the neoclassical competitive notion.

• Results of the production function where labour input is disaggregated into family and hired categories shed some light on testing the heterogeneity between family and hired labour. Also the derived shadow wages of these categories revealed that family labour are more productive at that margin relative to hired labour.
• Generally the production function analysis showed that factors of labour and average cost of variable inputs (proxy for capital) were found to be of utmost importance for the production of the studied crops.

• The Tobit regression for the off-farm part of the household incomes found that it was mainly affected by some physical and human capital variables, as well as some of the household characteristics.

• The econometric result of the log-linear income model revealed that the total income levels in Gezira Scheme were mostly affected by factors related to the physical capital (household resources) and the socio-economic characteristics of the studied farm households.

• The result of the wages regression in Gezira Scheme showed that wages determinants were mainly related to demand side of the labour market and the household characteristics.

• The model results suggested that the farm households in Gezira scheme allocate their labour time as if to maximize a family utility function.

• The model results showed that the production, consumption and marketed surplus variables might be increased if the adopted policy is the increase in labour supply and usage of more technological packages. However these variables were decreasingly affected under policies such as decrease in labour supply and increasing of cash crops selling prices.
• The model results presented that the inputs usage was affected increasingly under the increase of labour supply scenario, notably labour and capital, whereas the opposite occurred under the decease in labour supply scenario. However, slight or even no changes occurred under other scenarios.

• The comparison of the derived shadow wage of labour from the model results with the market wage assured the low returns of labour and that the studied farm households appeared to behave contrary to what stated in the neoclassical agricultural household models.

7.3 Recommendations and policy implications:

Based on the study findings, the following recommendations were suggested:

• As the participation of family labour in farm work was found to be low, more effort is needed to explore the factors behind this low performance of family labour.

• It may be of importance to enhance the productivity of both family and hired labourers through some sort of supervision to both categories.

• Emphasis should be placed on promoting the extension programs and other services for the farm households to enhance productivity.

• With regard to the low level of labour returns, urgent improvements of employment and earnings are needed in rural agriculture, through for example the adoption of varied technologies.
• In relation to inefficiency in the operation of the labour markets, it is recommended to create a more competitive labour market environment through fair market regulations, an effective labour market information system and labour organizations.

• In relation to the finding that, labour allocation is done in terms of shadow rather than market wages, more research is needed to explore the rigidities responsible from this deviation.

• A systematic data collection about the effects of new policy changes on the agricultural sector would be very useful in future policy formulations.

• National and regional labour market surveys are needed to ensure the availability of data for research and policy formulated alternatives.

7.4 Limitations of the study:

This study depends mainly on the data collected for one season, 2003/2004; therefore the usefulness of this study might be limited only to short term policies. Also it may worth mentioning that usually for a panel data concerning labour issues a large size sample survey is beneficial and of good coverage compared to such small size samples. This may need more time and effort so limitation of cost and time is also one of the study limitations.

Further studies may better concentrate on exploring questions related to wage structure, labour market outcomes and their relation with poverty alleviation.
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