The Role of Marketing Extension in Raising Awareness of Groundnut Farmers About Aflatoxin Contamination
Emphasis on Rain-fed Area in Kordofan.

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I dedicate this study to my parents who never doubted that it would not be completed, for their love and support, and for providing me with direction and purpose in my life.
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ABSTRACT

The study aims to identify the socio-economic characteristic of the groundnut producers and to assess their awareness of the recommended pre-harvest and post-harvest practices for groundnut production, which reduce the aflatoxin contamination. Aflatoxin is a naturally occurring mycotoxin produced by two species of fungi, Aspergillus flavus and Aspergillus parasiticus. Aflatoxin contamination of groundnut is a major hazard risk for both human and animal health and is one of the most important constraints to groundnut production and trade. The study also aims to design a set of marketing extension recommendations to assist extension officer.

To achieve the goals of the study, North and South Kordofan in the rain fed area were selected as the area of the study. The selection was because the aflatoxin contamination in groundnut is associated with drought stress, which is common in the rain-fed area than in the irrigated area.

The study used primary data collected through questionnaires, and direct observations plus secondary data from reviewing the literature and other available data set from various sources.
The survey was conducted during the period September to October 2003. Frequency distribution and percentages, correlation coefficient and chi-squares were used to test the hypotheses of the study.

The study revealed that, although it was observed that many groundnut producers had some level of education, their knowledge about aflatoxin was however not different from that of the illiterate ones.

In the absence of any regulations relating to marketable crop standards, producers in Kordofan sell their produce as they harvest them. There is no mechanism to detect aflatoxin contamination in groundnut during the pre and post-harvest management stage.

Poor extension service is a major constraint for improvement of the groundnut quality. The limited number of extension officers and technical staff are not specifically trained to provide the necessary support in the production, processing and marketing of groundnut and to improve its quality.

The study recommended motivation of the agricultural extension officer to educate farmers on the problems of aflatoxins and to package the market requirements into practical massages for groundnut producers. Also it recommended the strengthening of the agricultural information system and the use of the mass media to expose larger numbers of farmers to information about aflatoxin in groundnut.

Furthermore, the study recommended stronger linkages between research stations and extension to improve the pre- and post- harvest practices of groundnut producers to effect production of good quality groundnut free of aflatoxin.
خلاصة الأطروحة

(Aspergillus parasiticus، Aspergillus flavus)

(E. coli)
کردان، ولاية في السودان، المنتجة أثناء الدراسة تتفاوت وتحدد المستلزمات الكافية لامتلاكها، بل تؤدى إلى مستوى الطلبة، أيضًا، يوجد إن وآخر التعليم المترتبة.

鲑ارون يبيع السودان الفول استقرارًا ومساء ومقاييس علاقات وقيد الرقابة أو القوانين أو في الغياب في العمليات ذات الفلافة وتكسبني أو الفلاحة أو الحصاد بها، ممتدًا إلى التشريع والتسويق، كثرية التوجه، وتوفر أو توصيله في الأوقات، وفجأة في مستوى الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد، أو الجيدة، في الصيد.
CHAPTER ONE
INTRODUCTION

1.1 Introduction:

The annual legume groundnut, *Arachis hypogaea*, is an important cash crop in Sudan. Its seed are rich in edible oil (43-55%) and protein (25-28%). The groundnut, which is an important food crop today is generally, founded in the tropical, subtropical and warm temperate zones of the world. About two thirds of world production is crushed for oil and the one third is consumed as food. Its cake is used as feed or for making other food products and its hulls provide quality fodder (ICRISAT, 2003).

Worldwide, approximately 25.7 million tons of groundnut is produced annually from about 21 million hectares of cropped land. Asia alone produces 17.9 million tons which represented about 70% of global production. Africa produces another 20% of the groundnut production and generates roughly one-third of world exports, with Senegal, the Sudan, Zaire and South Africa being the largest producers in descending order. About 60% of Africa’s production comes from Western Africa (ICRISAT, 2000).

In the sixteenth-century, the traders transported groundnut from Brazil to Europe and West Africa then it spread into other parts of Africa. It has been transported to Philippines, China, Japan, Burma, India, and later to the USA and Spain. Groundnut entered the Sudan
through its western borders from West Africa, specially Nigeria before 200-300 years (Khidir, 1992).

Sudan occupies a unique geographical situation for the production of different types and varieties of oil crops. The prevailing conditions - long sunny summer days, mild winters, and so forth - are conducive to raising most oil crops. Adequate rains, canalized irrigation from the Nile and its tributaries fertile clay soils and long traditional husbandry practices, backed by proper research, all contribute to production of high yielding oil crops. Groundnut in Sudan is produced in irrigated and rain fed areas. Two main varieties (Ashford and Barbiton) are known in Sudan (Gabb, 1997).

Groundnut is an important cash crop in the Sudan, it contributes about 7% of the gross domestic product (GDP), and provide employment for 12% of the labor force (AOAD, 1995).

Groundnut is grown under irrigation mainly in central Gezira and in some small schemes bordering the River Nile in the North region. The rain fed crop is grown in Kordofan and Darfur in Western Sudan. Groundnut is mainly grown on sandy soils under traditional rain fed farming in Kordofan and Darfur states. It is not grown in the mechanized rain-fed sub-sector because of harvesting problem associated with the heavy clay soils. The production in rain-fed area is characterized by labour intensive and low input cultivation. The areas under groundnut in the traditional rain-fed sub-sector are about 85% of its total area in the Sudan, and 80% of its total area in Arab countries (ADAO, 1995).

The area under this lucrative crop had however, shown a declining trend during the 1980’s when its area dropped from over 2.0 million feddans in the early 1980’s to about 1 in the late 1980’s and to about 0.5 million feddans only in 1990/91 and 1991/92 seasons. This
was due to scarcity of seeds, high prices, as well as its marketing problem, drought stress and aflatoxin contamination. Drought stress is considered as one of stressful conditions which causing aflatoxin contamination in groundnut.

Aflatoxin is a naturally occurring mycotoxin produced by two species of fungi. Aspergillus flavus and Aspergillus parasiticus. Aflatoxins have been found not only in groundnut in all major producing countries, but also in cotton seed, corn, soyabean meal, fish meal, and other grains seeds and feeds.

Aflatoxin contamination of groundnut can occur during its cultivation in the field, as well as during harvesting, post harvesting, storage and processing (Garren and Jackson, 1973; International Trade Forum, 2002).

Aflatoxin contamination stops groundnut from entering the major markets more than any other factor. Importers are required by law to systematically test incoming shipments for the total amount of aflatoxins and reject those exceeding the permitted maximum levels. Exporters unaware of aflatoxin contamination issues, limits, regulations and standard risk costly rejections, claims, downgrading of shipments or the banning of the export origin (International Trade Forum, 2002).

In the Sudan aflatoxin contamination of groundnut has been reported to the extent that it affected it export (Habish and Abdallah, 1971; Habish and ElShafie, 1974; Ahmed, 1981; Hanafi, 1987; ElBeeli, 1989). Thus in the past few years there were some cases of certain Sudanese groundnut consignments which had been rejected as exports due to aflatoxin contamination (Hanafi, 1987). This resulted in a regrettable loss of foreign exchange.
In Sudan export of groundnut went down from 192 thousand tons in mid-seventies to 3 thousand tons only in mid-nineties largely due to aflatoxin contamination table (1) (Sid Ahmed, 1997).
Table 1.1 the Oil Seeds Company exports of groundnut from season 74/1975 to season 93/1994, (quantities in thousands of tons)

<table>
<thead>
<tr>
<th>Season</th>
<th>The quantity</th>
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<tbody>
<tr>
<td>74/75</td>
<td>121.8</td>
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<tr>
<td>75/76</td>
<td>282.7</td>
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<tr>
<td>76/77</td>
<td>206.9</td>
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<tr>
<td>77/78</td>
<td>154.7</td>
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<td>78/79</td>
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<td>80/81</td>
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<td>82/83</td>
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<td>83/84</td>
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<td>84/85</td>
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<td>85/86</td>
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<td>86/87</td>
<td>6.8</td>
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<td>87/88</td>
<td>97.5</td>
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<td>4.6</td>
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<td>89/90</td>
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<td>1</td>
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<td>91/92</td>
<td>6.5</td>
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<tr>
<td>92/93</td>
<td>5.1</td>
</tr>
<tr>
<td>93/94</td>
<td>3.4</td>
</tr>
</tbody>
</table>

Source: The Oil Seeds Company (1997)
1.2 Problem Statement:

The main problem is the lack of information among farmers of groundnut, about aflatoxin in groundnut. They haven’t any awareness about the pre-harvest and post-harvest practices associated with aflatoxin in groundnut.

The farmers always practice the groundnut production without any consideration to the factors that can increase the aflatoxin contamination in groundnut, and associated with their incorrect practices.

Aflatoxin contamination of groundnut is a major hazard risk for both human and animal health and is one of the most important constraints to groundnut production and trade in the Sudan. Nowhere in farmers’ productions and disposal process do they come across a situation when they are asked to check or verify aflatoxin contamination. None of the marketing channels where they dispose their groundnut production has any restrictions on the sales of aflatoxin contaminated products.

Farmers’ marketing practices and their relationship to the various marketing channels with which they trade their produce clearly indicate that they need not account for aflatoxin contamination as a prerequisite/ criteria for sale of their produce. Hence, they have no mechanism to look up for aflatoxin contamination during the pre and post harvest management of the crop.

Farmers need a clear information about aflatoxin in groundnut, its reasons, its effects on the health and trade and how to reduce the contamination in their crops, this job can be done efficiently by agricultural extension.

Agricultural extension is a very important component in the agricultural production process. Together with the existence of basic research results, it promotes agricultural development.

Extension work as an educational activity aims to transfer the new innovations and technology to small farmers. It focuses on the rural families in rural communities, helps them to improve their lives. Also, extension work helps the farmers in marketing their products. It teaches them new methods and techniques, to prepare their products for market competition. This type of extension work is called
marketing extension. However, there is a lack or complete absence of role of marketing extension in the Sudan to teach farmers, about aflatoxin in groundnut as a problem affecting the quality of groundnut.

1.3 Objectives:
1-To assess the influence of socio-economic characteristics of groundnut farmers on their awareness about aflatoxin contamination in groundnut.
2-To assess the awareness of farmers about recommended pre-harvest and post-harvest practices of groundnut production which reduce the aflatoxin contamination.
3- To determine the role of extension program in transferring the information about aflatoxin to the groundnut producers.
4-To design marketing extension recommendations.

1.4 Hypotheses:
1- The socio economic characteristics of groundnut farmers affected their awareness about aflatoxin in groundnut.
2- Farmers have not enough and clear information about aflatoxin in groundnut.
3- There is association between the knowledge among farmers, about factors affected aflatoxin contamination of groundnut and the pre and post-harvest practices.
2.1.1 Introduction

In the south of England, in 1960 about one hundred thousand young Turkeys died from an unknown disease which for convenience was referred to as “Turkey X Disease” (Blount, 1961). Affected birds lost appetite, became lethargic, and died within seven days after first showing symptoms. Postmortem examinations showed that livers of diseased Turkeys had been severely damaged. A diseased producing similar symptoms in ducklings and pheasants was soon afterwards reported from the same area (Asplin and Carnaghan, 1961).

In all the cases investigated, no pathogenic microorganism was consistently found to be associated with the disease, and all efforts to transmit the disease from affected to healthy birds failed completely. It was suspected that the disease was caused by ingestion of a poison, but all attempts to demonstrate the presence of known toxic substance in the feed, met with failure (McDonald, 1976).

Investigation on feed sources revealed that a common factor in all disease outbreaks was the inclusion, in the affected birds’ diets, of groundnut meal of a particular consignment from Brazil, which was being marketed by a London firm. Test birds fed on this meal soon developed symptoms typical to Turkey Disease. Feeding tests showed that ducklings were the most susceptible animals, and therefore used as biological indicators for the presence of the toxin (Blount, 1961).
This was of assistance in the extraction and concentration of meal (Sargeant et al., 1961).

Feeding trials with the contaminated meal soon showed that levels from 10-100 ppm (parts per million) of the toxin can cause the “Turkey X Disease” (Butler, 1969).

While research leading to characterization of the toxin was in progress much efforts were also being directed towards finding the origin of the toxin.

It was suspected that it might be of a fungal origin. Thus, workers at the Tropical Products Institute (TPI) London, had remarked upon the presence of considerable amounts of fungal mycelium in the fragments of groundnuts comprising the toxic meal from Brazil.

Non-toxic groundnut meals were examined and found to contain very little fungal mycelium. Attempts were made to culture the mycelial fragments from the Brazilain meal but without success, since the hyphal fragments were dead. However, mycelial fragments from a toxic sample of groundnut meal from Uganda were cultured giving a wide range of fungal species. It was found that only one of them produced a fluorescent substance. Physio-chemical and biological test proved that this substance was identical to the toxin isolated from the Brazilian groundnut meal (Sargeant et al., 1961).

The fungus involved was found to be a strain of the common, A. flavus and the toxin was given the name “Aflatoxin”. It was soon found that it was not the only one, but several related toxins are also involved and these were designated as aflatoxins B\textsubscript{1}, B\textsubscript{2}, G\textsubscript{1}, G\textsubscript{2}, ect.

The letters referring to their color (blue or green) of the fluorescence on thin-layer chromatograms.
Information on the role of aflatoxins in causing Turkey X Disease, was described according to the trials conducted in Nigeria in which rats, fed on sub-lethal doses of toxic meal, had developed cancer of the liver (Lancaster et al., 1961). In different parts of Nigeria aflatoxin was found to be present in materials collected from widely separated sites and that of a number of varieties tested (McDonald and Harkness, 1963). The tested pods were separated into three categories according to the conditions, which might influence infection, by the fungus.

*Asperigillus flavus* attacks groundnut as they mature in the soil and cause them to become moldy and sometimes contaminated with mycotoxins. Aflatoxin is a carcinogenic metabolite produced by A. flavus.

Seed attacked by A. flavus become shrunken and decay quickly. Cotyledons of germinating seeds are usually invaded first. (Garen and Jackson, 1973).

Plants infected with A. flavus have sparse roots, are chlorotic and temporally stunted. A most characteristic symptom of infection in the field is vein clearing of leaflets (Aujla et al., 1974).

On maturing plants moldy (peanut) groundnut pods, characterized by the presence of yellow-green spore masses, are often observed during windrow drying, especially during periods of unfavorable drying conditions. (El. Khadem, 1968).

2.1.2 *Aflatoxins in the Sudan:*

In the Sudan, oilseeds are of great importance in the traditional and irrigated agricultural sectors, of which groundnut is the most important of the oilseeds, both for export and local consumption.
Aflatoxin problem in Sudan was first realized and studied systematically in 1971. Samples of groundnut were collected from several groundnut-growing regions e.g., Gezira scheme and Kordofan State and analyzed for aflatoxin level and moisture content.

This study was induced by reports from German markets that Sudanese groundnut contain an unacceptable level of aflatoxin. The study confirmed the above report and high levels of aflatoxin were detected in Gezira and Kordofan groundnuts. As a result a training program was arranged for extension staff from Gezira scheme on the method of aflatoxin control (Habish and Abdallah, 1971).

The risks from consumption of groundnut and groundnut product, contaminated by aflatoxin, became well known. The Sudanese media took up the matter and started to warn the public against the consumption of native products such as groundnut butter (Dakoa), especially because this product has not been subjected to any method of assessment (Habish, and Abdallah, 1971).

Further studies on the presence of aflatoxin in Sudanese products had been carried out at the Faculty of agriculture in Shambat. These studies included incidence of aflatoxin in Haricot Bean (Fasolia) and in poultry feed based on groundnut cake yielding positive results (Habish, 1971).

2.1.3 Factors affecting aflatoxin in groundnut:

Many environmental factors, including soil moisture, temperature, and relative humidity affect the epiphytology of A. flavus in groundnut pods. Biological factors, including damage to pods increase the chances for contamination. Garren and Jackson (1973) listed other factors affecting the growth of A. flavus. Soil population of A. flavus range from less than 1 propagule per
gram of soil (Griffin and Garren, 1974) to 104 propagules per gram of soil (Bell and Crawford, 1967; McDonald, 1969).

2.1.3.1 Moisture and Relative Humidity:

The most important factor in growth and production of aflatoxin by A. flavus, is the moisture content or the relative humidity (RH) surrounding the substrate (Austrwick and Ayerst, 1963).

No aflatoxin occurred at 83% RH in any treatment. This limiting relative humidity is in equilibrium with 10.5-11% SMC. Research has indicated that certain conditions may result in either pre-harvest or post-harvest infection and aflatoxin formation by A. Flavus in groundnut (Diener, 1973).

Fifteen years ago, most experimental data indicated that there was little invasion of seed in intact and undamaged immature and mature pods in the ground by A. flavus, and little or no aflatoxin present in seed before lifting at the normal harvest time. (Norton et al., 1956; McDonald et al., 1964; Joffe and Borut, 1966). It appeared that invasion of peanut pods and seed by A. flavus and other fungi usually occurred during curing when the variety was dug near maturity (Austwick and Ayerst, 1963; McDonald and Harkness, 1964; Diener et al., 1965).

When drying of the groundnut lowers the seed moisture content rapidly and steadily downward within 4 or 5 days to safe storage moistures, little opportunity for fungal invasion occurs. No varietal resistance was observed (McDonald and Harkness, 1963). After lifting peanuts were more rapidly invaded by A. flavus drying in windrow and stack at 14 to 30% SMC. (McDonald and Harkness, 1964; McDonald et al., 1964; Dickens and Pattee, 1966)
2.1.3.2 Temperature and time:

According to Semeniuk, (1954) Asperigillus flavus has been classified as amesophilic fungus having cardinal growth temperature as follows = minimum 6-8 c, optimum 36-38c, maximum 44-46 c. The minimum and maximum temperatures for growth are affected by moisture, oxygen concentration, availability of nutrients, and other factors. A. flavus has a higher maximum temperature for growth on natural substrates than on synthetic media (christensen, 1957).

The optimal temperature and time for aflatoxin production by A. flavus on sterilized peanuts in culture flasks were 25c and 7-9 days (Diener and Davis, 1966). At 30c the optimum was reached in 5-7 days, while at 20c, the maximum amount of aflatoxin was produced in 11-13 days.

Research on the relationship of time to aflatoxin formation in peanuts after digging has given varying results. Under tropical conditions in Africa, groundnut that were free of toxin at digging contained detectable toxin in 48 hours (Bampton, 1963).

Contamination of seed with A. flavus and aflatoxin did not occur until at least 5-6 days after lifting. (Mc Donald and Harknes, 1964). More A. flavus and other fungi in seed from slow dried pods (attached to plant) than from rapidly dried pods (Mc Donald and Harknes, 1965). Jackson (1965) also reported high levels of aflatoxin in slowly dried pods as compared to rapidly dried pods.

In controlled environment studies with cured peanuts, the upper limiting temperature for growth and aflatoxin production by A. Flavus was 40.5c ± 0.5 at 99 % RH in 21 days for sound and broken mature seed, immature seed, and seed of unshelled peanuts. The lower
limiting temperature was 13+1°C for sound and broken mature seed incubated up to 84 days at 99% RH. Some aflatoxin developed in immature seed at 15°C in 21 days, although none was found at 14°C in 42 and 84 days. Negligible amount of aflatoxin developed in seed from intact pods at 20°C in 21 days. In 42 days a large amount of aflatoxin developed at 18°C, but non-occurred at 16°C (Diener and Davis, 1970).

2.1.3.3 Pod and Seed Damage:

Another factor that influences the invasion of peanuts by A. flavus with subsequent aflatoxin production is physical and biological damage to the peanut shell and seed. The thesis that seed of unblemished, intact immature and mature pods are rarely invaded by A. flavus under most growing conditions is widely accepted (Diener, 1973).

Experimentally, it was demonstrated that the percentage of seed colonized by A. flavus increased with shell damage and incubation time (Wright et al., 1976).

Other workers have reported that the levels of A. flavus infestation and aflatoxin in the seed of damaged pods always far exceeded that of seed from sound pods (McDonald and Harkness, 1963, 1964, 1967, Mc Donald et al., 1964) Schroeder and Ashovorth, 1965; Dickenes and Khalsa, 1967; Mc Donald, 1969 b; Schroeder and Boller, 1971; Porter et al., 1972; Subrahmanyam and Rao, 1974).

The damaged groundnut pods contained 2 ppm of aflatoxin, compared with sound pods, in which the aflatoxin content did not exceed 0.005 ppm. (Ashworth and longley, 1964).
2.1.3.4 Effect of drought stress

Drought stress has been the factor most frequently associated with aflatoxin occurrence in peanuts before digging. Drought stress probably increases susceptibility to fungal invasion, since it decreases the moisture content of the pod and seed and greatly lowers the physiological activity of the groundnut. In Nigeria, aflatoxin was detected in seed in a late planted grope in a sandy soil in a semi-arid region, although the plants had been in the ground for only the normal length of time (Bampton, 1963).

Aflatoxins production occurs in groundnut kernels when the Aspergillus flavus parasiticus fungus is presented under conditions of lowered water activity (in the range of 0.8 to 0.95) and favorable temperatures (25 to 32°C) (Dorner et al; 1989). Such conditions occur at both pre and post-harvest stages of groundnut, depending on the duration of end of season drought and soil temperature.

High probability of end-of-season droughts, with associated aflatoxin incidence, clearly threatens the viability of rain fed groundnut in the Burnett region of Queensland (Wright and Hansen, 1997).

Seeds become more susceptible to A. flavus invasion when the soil moisture in the pod zone approached levels at which moisture moved from the pod into the soil and SMC dropped below 31% (Dickens and Pattee, 1966).

It has been suggested that in over-mature peanut seed there is a drop in moisture content to a more susceptible state associated with the physiological change from active growth to one of low metabolic state (Mc Donald and Harkness, 1964). In 1963, Nigerian peanuts left in the ground 4 weeks after maturity contained aflatoxin (Mc Donald and Harkness, 1967).
Data from Alabama in the same year show that a much higher percentage of A. Flavus invasion occurred in over-mature seed and pods than in immature and mature seed and pods from the same plants at harvest (Diener et al., 1965).

In Nigeria, aflatoxin was associated with over-mature Pods and seed and with pods from dead plants with seed of low moisture content (McDonald et al., 1964).

2.1.4 Disease in man and animals:

Fungi and their toxic metabolites (mycotoxins) in grain, seed, and feeds have been a problem for man and domesticated animals for hundreds of years. Diseases caused by the ingestion of foods made toxic by fungi, have resulted in mortality in man and animals (Wyllie and Morehouse, 1977, 1978 a, b).

Aflatoxins are food-borne toxins, produced by the fungi A. flavus and A. parasiticus, and are regarded as potent toxins. The most carcinogenic member of this group is aflatoxin B₁ (IARC, 1993). Which is also the most commonly found.

Workers engaged in post-harvest activities related to shelling, bagging, storage, transport, etc... might be exposed to aflatoxin through the respiratory route. There is evidence from epidemiological studies to indicate that aflatoxin in respirable particles pose a potential occupational hazard (Dvorackova, 1976).

Farmers who clean out moldy grains from store houses suffer from burning of the eyes, nose and throat, chills, fever and dry irritating coughs (Emanuel et al. 1975).

Aflatoxins have been implicated in the etiology of Hepato Cellular Carcinoma (HCC), which is one of the majors cancers in the world and a public health concern in many developing countries. Several
epidemiological studies in areas of high aflatoxin exposure, particularly in Africa, southern China and Taiwan have further substantiated this idea. (Peers et al, 1987; Yeh et al, 1989; Lunn et al, 1997).

Groundnut butter consumption has been identified as a strong risk factor of HCC in a region with endemic aflatoxin contamination in Sudan (Omer, et al 2001).

Out-breaks of aflatoxicosis in farm animals have been reported from many areas of the world. The liver is mainly affected in such Out-breaks. A feed of aflatoxin as low as 300 ug/kg can induce chronic aflatoxicoses within 3-4 months.

Reports on the effect on the aflatoxin on all the species infected indicated that the first clinical sign of aflatoxicoses are inappetance and weight loss. The most important pathological effects is liver damage. (Carnagham, 1965).

2.1.5 Aflatoxins and Marketing of Groundnut:

2.1.5.1 Marketing and Related Regulations:

“Marketing can be defined as the series of services involved in moving a product from the point of production to the point of consumption. Marketing also include harvesting techniques, grading and storing of crops and packing, transport, storage, processing, distribution and selling of products” (FAO, 2000).

2.1.5.1.1 Harvesting and Time:

Harvesting is the most critical operation that needs to be undertaken at precise time. Fifteen years ago, most experimental data (Diener, 1973) indicated that there was a little invasion of seed in intact and undamaged immature and mature pods in the ground by A. flavus, and little or no aflatoxin present in seed before lifting at normal harvest time (Norton et al, 1965; McDonald et al, 1964; Joffe and Borut, 1966).
It appeared that invasion of groundnut pods and seed by A. flavus and other fungi usually occurred during curing when the variety was dug near maturity (Austwick and Ayerst, 1963; McDonald and Harkness, 1964; Diener et. al, 1965).

Timely harvesting could reduce crop moisture to a point where the formation of the mould would not occur. (International Trade Forum, 2002).

Delay in harvesting may lead to over maturity, germination of seed before harvest and/or damage to crop due to intermittent rains, which could provide conditions suitable for aflatoxin contamination (Kolli and Andy, 2003).

2.1.5.1.2 Harvesting Techniques:

Technique used to harvest groundnut, manually or mechanically, may cause the damages to pods and kernel. While mechanization has its advantage, working with machines has a few implications for damages and consequently for possible aflatoxin contamination. According to farmers, harvesting with tractors, stripping of pods with threshers and shelling of pods with decorticators causes physical damage and injury to the pods and kernel (Kolli and Andy, 2003). Pod and seed damage influences the invasion of groundnut by A. flavus with subsequent aflatoxin production in physical damage to the groundnut shell and seed (Diener, 1973). The minimum damage of shells during mechanized harvesting of the crop reduces significantly the mould contamination (International Trade Forum, 2002).

2.1.5.1.3 Drying:

As the crop, is left for drying in the field for 3 to 4 days and because of improper drying of the crop due to labor shortages or if the crop gets affected due to intermittent rains, fungal growth may develop before the crop is transported from the farm. When drying of the groundnut lowers the seed moisture content rapidly and steadily downward within 4 or 5 days to safe storage moisture, little opportunity for fungal invasion occurs (McDonald and Harkness, 1963). After lifting groundnuts were more rapidly invaded by A. flavus during drying in windrow and stack at 14 to 30% SMC (Mcdonald and Harkness, 1964; McDonald et. al., 1964; Dickens and Pattee, 1966).

In the Sudan, under Gezira conditions and with groundnut lifting taking place towards the end of November and early December, even the unseparated nuts dry fairly quickly (ElNur and Ibrahim, 1970).
However, atmospheric RH during this time of the year is very unlikely to exceed 70%, which is well below the minimum for A. flavus growth. The most serious operation is the washing of the groundnut after harvesting. It is an undesirable and if it is done, it must be followed by immediate spreading for 48-72 hours to ensure quick drying. More A. flavus and other fungi invade in seed from slow dried pods than from rapidly dried pods (McDonald and Harkness, 1965). Jackson (1967) also reported high levels of aflatoxin in slowly dried pods as compared to rapidly dried pods. Artificial drying after 4-6 days in the field resulted in toxin free seed, but that samples left for 8-12 days or sun dried for 10-16 days resulted in moderate aflatoxin contamination (15-500ppb) (McDonald and A’Brook, 1963). Improper field drying or wetting due to rains may cause development of diseases that may generate aflatoxins during the stacking period (Kolli and Andy, 2003).

2.1.5.4 Storage:

Groundnut is a semipershable crop and is subject to losses in quality during storage through microbial changes (flavour change, rancidity, viability loss, etc.), physical changes (shrinkage, weight loss, etc.) and absorption of odours and chemicals. When subjected to suitable storage environments, clean groundnut can be stored for several years (Woodruff, 1973). A small number of farmers transfer groundnuts directly from the buying point to the shelling point. However, most of groundnut must be stored until they can be shelled. Storage periods range from a few days to about 10 months (Hutchison, 1973; Dickens and Hutchison, 1976).

The importance of proper storage and its role in depressing A. flavus growth and as a result, reducing the risk of aflatoxin contamination was well documented (Bhat, 1987). High initial contamination of the seeds with A. flavus was always associated with increased toxin levels during storage (Sallam, 1990). Aflatoxin content of stored groundnut, increased with storage time to concentrations as high as 100ppb (Eldrge, et. al., 1965). Other workers supported the fact that, stored groundnut seeda contained more aflatoxin than fresh seeds (Purchase, 1967; Welty and cooper, 1968).
The intensity of aflatoxin in fresh groundnut seed samples, was low, where as in seeds stored for 6 months, the intensity of aflatoxin was high (Jackson, 1965).

High initial contamination of the seeds with A. flavus was always associated with increased toxin levels during storage (Sallam, 1990). Improper post-harvest handling and storage of the produce such as high moisture, temperature and insect or mechanical damage can influence the incidence of fungus that produces the toxins (The Hindu, 2002).

Inappropriate storage facilities and/or improper packing of products could result in mould contamination during storage. Strict control of storage facilities and conditions (including temperature, moisture, physical damage of the product through handling or pests) prevents or reduces mould growth (International Trade Forum, 2002).

2.1.5.2 Domestic Marketing:

Domestic marketing of groundnut reflects largely certain aspects of groundnut production including the structure of the main channels through which contaminated and free groundnut moves from the field to different buyers. The marketing channel is defined as the sequence by which goods pass from producers to consumers. Any attempt to understand the marketing system requires a good knowledge of marketing channels.

2.1.5.2.1 Traders:

Traders purchase pods directly from farmers or through the middlemen and sell it to the next set of users. Depending upon the market conditions and individual capacities, traders maintain stocks of groundnut pods to a maximum duration of six month. The groundnut market does not react by the presence of aflatoxin contamination.
However, the entire markets reacts to the presence of visibly damaged or inferior quality pods in the lots, and so the trader scrupulously follow the rules to reduce the prices of such material. It is to cater to such market situations that the traders acquire an understand of the situations in which groundnut pods can get affected.

Groundnut pods can be damaged if the pods contain high levels of moisture or due to soaking in rain while in storage, and at farmers level during stacking of crop before stripping of pods and improper drying before stacking.

From one spot to another the groundnut should pass through many marketing services, such as cleaning, grading, sampling, handling and storage. Sampling and grading of groundnut take place in auction markets such as Elgadarif, Elobid and Elnuhood market. Local methods of harvesting, curing, drying, threshing, marketing and storage are crucial factors in the aflatoxin problem. (ICRISAT, 1987).

The market however, has neither the knowledge nor the facilities for grading of groundnut depending on contamination such as aflatoxin.

2.1.5.2.2 Decorticating Units:

There are four factories in the Sudan for the production of selected groundnuts. They are shelling the pods, segregating and grading the kernels and marketing them to their appropriate demand areas. They usually buy groundnut pods directly from the farmers, middlemen and traders and in turn act as traders of groundnut kernels.

1-Bagair factory: this factory specializes in shelling and sorting groundnuts from irrigated areas. Its production capacity is 800 tons which is equivalent to the shelling and sorting 40000 sacks daily.
2-Port Sudan factory: exclusively for sorting West Sudan groundnuts as shelling is done in production areas.

3-Sheikh Mustafa Co Bagair: the production capacity in shelling and sorting is 10000 sacks daily which produce 200 tons of shelled groundnuts.

4-Fufu factory: a small private sector factory, which produces 12 tons of dicorticated groundnuts daily. It doesn’t engage in export of groundnut.

The decorticating units are more specific in what they buy. The highest prices that are offered for purchase of groundnut is that given to hand picked selected for human consumption.

The decorticating units have enough storage capacities to store the pods. They decorticate pods and sell the kernel without long storage.

The storage of decorticated groundnut in Port Sudan, made it prone to increase moisture content, and aflatoxin content more than the groundnut stored at similar warehouse at Elbagair. Thus the higher levels of kernel moisture content, and also of both the fungus and the toxin were reported from Port Sudan despite the fact that the store houses facility was large and well ventilated as that in Elbagair. Possibly those variation were attributed to the high relative humidity (74%-86%) prevailing in Port Sudan during the period of storage (Omer, 1992)

2.1.5.3 Exports:
Many importing countries have set strict quality standards to control the health risk from mycotoxin contamination. Unfortunately, most poor small-scale farmers in the semi-arid tropics cannot meet these standards.

In USA, a provision of USDA of Groundnut Marketing Agreement (Groundnut Administrative Committee, 1978) requires that all of the seeds from each sample of farmers’ stock groundnuts be examined for visible growth of aflatoxin producing mold *A. flavus* (Dickens, 1977).

The marketing agreement regulates both the incoming and outgoing quality of groundnut. With respect to the incoming quality, the marketing agreement divides farmers’ stock (groundnut in the shell received from the farmer) into segregation’s I, II, III groundnut according to damage as well as the visual presence of *A. flavus*.

Segregation I groundnut is low in damage and are free from visible *A. flavus*. These groundnuts are available for human consumption.

Segregation II and III groundnuts, on the other hand, are higher in damage, and in the case of segregation III, there is visible *A. flavus*. Unless an extreme shortage of groundnut exists, segregation II groundnut is not permitted to enter the domestic edible channels and must be crushed for oil. Segregation III groundnuts must always be crushed. In Sudan, such marketing procedures and regulations are absent.

In 1997, the European Commission proposed maximum limits for aflatoxin in certain foodstuffs. It has banned the imports of groundnut with aflatoxin B1 content above 6ppb. The World Food Organization categories samples with over 30ppb as unfit for human consumption. However, groundnut and groundnut products available in Africa can contain over 1000ppb (ICRISAT, 2000).

Strict quality regulations imposed by many developed countries have contributed to severe decline in international trade. Exports have fallen sharply in many developing countries (ICRISAT, 2000). Many groundnut importing countries have placed limits on levels of aflatoxins permissible in groundnut and groundnut products (Table 2.1.1 and Tabl 2.1.2).
Countries depending on export of aflatoxin susceptible commodities e.g. groundnuts are obliged to establish export limits that meet importers’ requirements.

Table 2.1.1 Tolerance Limits in ppb. for aflatoxins by European Union.

<table>
<thead>
<tr>
<th>Purpose</th>
<th>B1</th>
<th>B2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundnut for directs consumption.</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Groundnut for furthers processing.</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Milk and milk products.</td>
<td>0.5</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: (Nautiyal, 2003)
Table 2.1.2 Maximum possible levels of aflatoxin in imported groundnut for human consumption and poultry feeds.

<table>
<thead>
<tr>
<th>Country</th>
<th>Aflatoxin type</th>
<th>Maximum level ppb in foods stuffs.</th>
<th>Maximum level ppb In livestock feed.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>B1</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>France</td>
<td>B1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Germany</td>
<td>B1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Ireland</td>
<td>B1</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Italy</td>
<td>B1</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Netherlands</td>
<td>B1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Sweden</td>
<td>B1,B2,G1,G2</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Uk</td>
<td>B1,B2,G1,G2</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>USA</td>
<td>B1,B2,G1,G2</td>
<td>20</td>
<td>2</td>
</tr>
</tbody>
</table>

Source: Freeman et al, 1999, ICRISAT

2.1.5.4 Quality control:

One of the most important problems encountered in the marketing of groundnut is the problem of specification and quality control emanating from liberalization of agricultural trade and agreements of the World Trades Organization (WTO).

The quality attributes, defined by the final end products made from groundnut vary among the developed and developing countries. In developed countries groundnut is mainly used for making groundnut butter and consumed roasted or in confectioneries.
Mean while, in several developing countries it is mainly processed to extract oil. Most developing countries have not given much attention to quality.

For example, the general guidelines for quality of groundnut pods and kernels formulated by the National Resources Institute of the United Kingdom, Ministry for Overseas Development are: (i) Pod colour and type, size, pod texture, cleanliness, freedom from damaged and absence of blind nuts; for pods and (ii) grading for size or count, shape skin colour and conditions, resistance to splitting, moisture content, cleanliness, oil content and flavor; for kernels (Nautiyal, 2003).

The number one problem that kept worrying the exporters of groundnut and is likely to affect considerably the selection of groundnut for exports in free world trade is the problem of aflatoxin. This is the most important consideration for export quality today. All countries don’t permit groundnut affected by aflatoxin to enter their territories but they differ in specifying the percentage of aflatoxin in groundnut. The general trend, however, is to reduce that percentage. It was originally 5 parts per billion ppb (Eldooma, 2000).

CHAPTER TWO
LITRATURE REVIEW
SECTION TWO
CONCEPT OF AGRICULTURAL EXTENSION

2.2.1 The term extension

The meaning of the term agricultural extension is well known in extension organizations and services, but is not well understood in the wider community. Rural extension is now a common activity in most countries in the world and its basic elements are program and project formulation to bring about changes in rural areas. There are many definitions of extension and each deserves attention. Briefly it may be described as a system and process of service and education designed
to meet the needs of people whether in urban or rural areas. The main objectives of extension are to teach and help people to acquire knowledge and skills and inspire them to action.

The term agricultural extension means different things to different people. World Bank’s extension project’s portfolio suggests that extension might be described as the process of helping farmers to become aware of and adopt improved technology from any source to enhance their production efficiency, income and welfare (Puncell and Anderson, 1997).

UNDP views agricultural extension as a central strategic component in the agricultural development process, including both technology transfer and human resource development in developing countries. If extension’s message and dissemination strategy is targeted to include small-scale subsistence farmers, especially women and young families, it can be appositive force for alleviating poverty and for broad based agricultural development (UNDP, 1999).

However, for the extension work to be effective, it must have people’s own actions spring out of their knowledge, understanding and conviction (Nagel, 1997, Puncell and Anderson, 1997, Rolling, 1990, Roberts, 1989 and Axinn and Throat, 1972).

Oakely and Garforth (1985) explained the word extension by looking at a number of statements that have been written about it and identified the following common points that explain the term extension.

They all stressed that extension is a process, which occurs over a period of time and not a single, one time activity. They also underline extension as an educational process which works with rural people, supports them and prepares them to confront their problems more successfully.
There are different terminologies to explain the concept of extension used by different countries. Van Den Ban (1985) in Rolling (1990) had pointed out that in UK, Germany and Scandinavia, the focus is on advisory work, while in the American tradition, the term extension education is used to emphasize that they are dealing with an educational activity which seeks to teach people to solve problems by extending information. The Netherland uses “voorlichting” which means keeping a light in front of someone to follow the extension worker to find the way, while in France the term “vulgarisation” indicates that extension is a question of simplifying information so that the vulgar or ordinary people can understand it.

Rolling (1990) gave the following different names and terms to extension according to the purpose it is expected to achieve depending on the policy tradition within which it functions.

**2.2.1.1 Informative extension**

In the conservative tradition it is seen as an instrument for helping people to make well-considered choices among alternatives which extension had provided. The emphasis is on supporting the individual to make optional decisions with respect to achieving his or her own goals. The individual is seen as free to use or not to use the extension recommendations.

**2.2.1.2 Formative extension or human resource development:**

In both traditions there is considerable emphasis on the use of extension for the development the human being to form or enhance his or her capacities to make decisions to learn, to manage to communicate with others, to analyze the environment, to be a leader, to stand up to oppression and to organize and so forth.
2.2.1.3 Persuasive extension:
The use of extension as a policy instrument for achieving societal objectives or collective utilities has been embraced by governments in all countries when it comes to inducing preventive behavior with respect to environmental pollution, health hazards, vandalism, traffic safety, and so on. Such preventive behavior is in the interest of society as a whole or of future generations, but not necessarily in the short term interest of the individuals who are the target of such extension. The above definitions outline a number of different processes that have some similarities but also have important shades of differences. Most agricultural extension services use a mixture of all these processes, but not always the same combination of component elements.

2.2.2 Agricultural extension in historical perspective:
As a formal institution, agricultural extension is quite young worldwide. Even in high income countries where extension began at earlier dates, fiscal commitment took significant upswings following the World War II when a backlog of science and technology had accumulated (Rivera, 1999). An FAO survey (1987) of 207 agricultural organizations in 115 countries reported that fifty percent of these organizations were either established or recognized in the past two decades. Agricultural extension was organized informally in the 19th century in several industrializing countries around the world, but it was not until the end of that century that its function became formalized within public institutions usually ministries or departments of agriculture. Japan was the first country to establish formal policy mandate to a national agricultural extension system, followed in 1914 by the United States (Axin and Thorat, 1972). In most countries
Agricultural extension did not become institutionalized until the 1950’s.

There are differences in the historical and technological context of agricultural extension in developed and developing countries. Today’s agricultural extension activities in Western Europe and the United States have their origin in general agricultural promotions and education activities that date from the early nineteenth century. The initiatives were largely privately sponsored and included the creation of agricultural societies. It was largely the demand from farmers and their organizations, which led to increasing government investment in agricultural technology generation and transfer (Baxter, Slade and Howell, 1989).

Agricultural extension activities in developing countries on the other hand largely grew out of the rural administration of colonial governments. Agricultural officers and their staff were closely bound to the work of the administrative services and much of their work was concerned with revenue collection and enforcing regulations on such matters as soil conservation and animal health. Where they were involved in giving advice on how to improve agricultural production, extension activities normally focused on the introduction of new crops for export and this often entailed producers to adopt recommended practices. Extension methods were general and regulative.

Training was concentrated on progressive farmers. The establishment of state schemes reinforced this style (Moris, 1981).

Broadly speaking the extension system inherited by former colonies from the Mid 1960s onward shared a number of common
features. They were primarily government services subject to a high
degree of central direction and hierarchical in structure. Generally
they had poor linkages with agricultural research and there was little
farmers participation in the design and content of extension work.

As a consequence, the technologies promoted by extension
services often had little reference to traditional farming systems nor
did they pay attention to farmers’ access to resources. The difficulty of
establishing an institutional structure responsive to farmer’s demands
was further exacerbated by post-independence developments in rural
development administration (Boyce and Evenson, 1975).

2.2.3 Agricultural extension works with different target groups:

It is a common tendency on the part of individual extension
workers and whole extension systems to concentrate on the larger and
more progressive farmers who can expand production most quickly.
This is part of a broader syndrome of concentrating on these activities
and audiences that will produce a good statistical record with which to
impress the supervisor at the next level or to convince national policy
and budget authorities that the extension service is performing well
and merits more support (Coombs and Ahmed 1974). The progressive
farmer’s strategy is clearly an attractive one especially from
development agency’s view points. Because of the fact that diffusion
research has developed generalization supporting the progressive
farmer strategy, that the strategy has indeed became widely practiced
(Rolling, 1990).

Acceptance of the progressive farmers of innovation offered by
extensionist had blinded the researchers and practitioners to the
innovations themselves and to the fact that the laggard on the
extension scale could be an innovator with respect to his or her own
peer group (Rolling, 1990). In relation to the same issue, Leonard
(1975) and Tendler (1982) and Sims and Leonard (1990) argued that
the effectiveness of agricultural extension agencies in serving a certain client was strongly influenced by that clientele. Their relationship made it difficult to direct agencies toward another clientele. The old clientele protested while the new clientele did not yet form an effective constituency that could turn over the agencies. As a result of ineffectiveness of the progressive farmer’s strategy in serving the rural poor, there are callings for extension and research to act as rather neutral change agencies serving different types of individual clients and that change agencies could easily be re-targeted to reach different categories of users. Rolling (1990) raised the issue of targeting extension offerings, and argued that the introduction of use of target categories in extension automatically implies a concern for adopting the offering to different target groups an approach which had not made much progress in the past. He argued further that small is beautiful, and that agricultural researcher and the opportunities builders should deliberately design their products to suit members of designated target categories.

To the extent that developing countries were concerned such designated target categories are in particular, small farmers and rural poor. Retargeting extension to reach different target groups especially the poor needs a new paradigm of agricultural extension. In this paradigm, the role of extension is not only to deliver technology but also to develop human resources. To empower people to exercise effective demand for appropriate services. This extension function includes mobilization, organization, training and system management,
in addition to transfer of technical innovation (Rolling and Jiggins 1993, Oakely and Garforth, 1985; Hunter, 1980).

2.2.4 The use of communication:

Communication forms a large part of the extension agent’s job. By passing on ideas, advice and information, he or she hopes to influence the decisions of farmers. He or she may also wish to encourage farmers to communicate with one another. The agent must also be able to communicate with superior officers and research workers about the situation faced by farmers in his or her area (Okely and Garforth, 1985). Couch and Chamala (1981) reviewed some empirical studies on communication to provide a holistic picture of communication strategies used by extension officers and the types of audience (farming community) using those services. The following generalization can be made from the studies reviewed.

Extension personnel spent more than half their time in administrative activities not necessarily related to the client community. The majority of farmers did not have direct contact with extension services, which did not use mass media effectively.

Characteristics of the farmers who used extension services indicate that farmers with higher socio-economic status, education and innovative ability are more likely to approach the extension services for advice or less frequently are approached by some extension agency.

2.2.5 The role of agricultural extension in agricultural development:

If development is to take place and becomes self-sustaining, it will have to start in rural areas in general and the agricultural sector in particular (Todaro, 1977). Development of agriculture is an integral part of economic development. Few countries have experienced sustained economic growth of their agricultural sector. Similarly all
countries that have experienced significant growth in agriculture have also achieved a more rapidly growing economy. The development of agriculture sector is therefore not a first end in itself, it also has a direct and beneficial effect on overall economic development. Todaro argued further that agricultural output growth for most developing regions remained stagnant during the 1960s (the so-called development decade). The declined share of agricultural output in total GNP revealed that, although the agricultural sector accounts for most of the employment in Third World countries, it accounts for much lower share of the output. It can be said that the Third World agricultural employment was typically twice as large in proportion to the total as agricultural output similarly reflected the low level of agricultural labour productivity. So the development of agriculture required the shift from traditional to modern methods of production that include new technological component (such as new varieties cultural practices, commercial fertilizer and pesticide). Puncell and Anderson (1997); Evenson, (1997) and FAO, (1984) stressed that the quality, capacity and performance of farmers in agriculture are fundamental indicators of the level of agricultural sectors’ efficiency, productivity development and sustainability. However, high capacity and good performance in farmers are not inborn qualities, they are acquired. Unfortunately, most farmers in the developing countries have a low level of formal education and extremely few have opportunity to study agriculture in the formal school system. Furthermore, technology and the performance requirements of farming even in developed countries are constantly changing. Therefore, even the few who have had the advantage of formal schooling may not be able to keep with the new trends and changing requirements of modern agriculture.

For these reasons most governments and international development agencies recognized the need to support and develop agricultural extension. FAO report (1990) on the Global Consultation on Agricultural Extension indicated that most countries have some type of extension services. Estimated expenditure is US$ 6 billion a year and some 600,000-extension workers were engaged in offering out-of-school agricultural education needs of the farming population. Even so only small fractions of farmers were being served. By the end
of the century, it is estimated that some 1.25 million extension workers will be needed (FAO, 1990).

The term extension was first used in connection with agricultural improvement over a century ago (Ture, 1929), and what we now call agricultural extension activities pre-dates that usage by many years. In recent years however, there has been much interest in the role of extension in agricultural development and in the organization and effectiveness of agricultural extension programs in developing countries (Rivera and Sehran, 1987).

The contributions of agricultural extension are found throughout the world and are many and varied. The best known during 1970s was “the Green Revolution” where there was an increase of production of food through the rapid spread of short-stem varieties of wheat and maize and rice in many parts of Asia and Latin America and in some African locations.

When the international and national agricultural research systems introduced these varieties, agricultural extension often provided the interface which made them known to farmers (Axinn, 1988). Accordingly, effective extension work in Pakistan contributed significantly to the rapid spread of mex-pack wheat and soon after wards the same extension organization promoted use of the rice varieties from the international Rice Research (Antholt, 1991 and Lowdermilk, 1981). Stories of successful achievements of agricultural extension activities in some developing countries identified by (Axinn, 1988), include spread of farmers associations in East Asia; poultry production by rural youth in Nigeria; Bean improvement in
Colombia; fuel wood plantation in Malawi; dairy marketing in India and livestock disease control in Africa. Agricultural extension has contributed in helping rural people learn to organize, many types of groups as cited by (Axinn, 1988), including small farmers development in Nepal and Malawi; Radio listener groups in Colombia and India. The village councils of Egypt and the Sukuma livestock growers in Tanzania.

It can be concluded that agricultural extension’s role in agricultural development is largely catalytic. Benor and Baxter (1984) argued that without extension guidance, farmers often are unable to exploit the opportunities available to them. Van den Ban and Hawkins (1996) stressed the critically important role of agricultural extension in increasing food production especially in less industrialized countries, because the demand for food is increasing and at cost which is competitive on world market. It is extension however, that helps farmers take advantages of research finding and technological advance, quickly adjust to seasonal and economic conditions and effectively use support services to increase production.

2.2.6 Agricultural extension personnel:

As cited in Halim and Ali (1997), there are currently more than 600,000 extension workers world wide comprised of administrative staff, Subject Matter Specialist (SMS), field workers and some multipurpose unidentified personnel. The Asian and Pacific countries have absorbed more than 70 percent of them. The percentage of extension personnel by position as reported by Swanson, et al. (1992)
was 7 percent administrative, 14 percent SMSs and 79 percent field staff, with regional differences.

Almost 13% of extension workers are women with significant regional differences. The ratio of SMSs to field staff is also low in Asia, Africa, the Near east, and Latin American countries, varying from about 1:11 to 1:14. The ratio for countries of Europe and North America varies from 1:1.5 or 1:1.6. The worldwide ratio of SMSs to field staff is 1:11.5 (Swanson et al. 1992).

Swanson et al. (1992), concluded that the deficiencies in knowledge, skills and ability among extension personnel, particularly those of Asia, Africa and Latin America are remarkable. About 39% of the extension personnel worldwide have secondary level and 33% an intermediate level education. Moreover, within each region, there is a lot of variation in basic academic qualifications of the front-line extension workers, SMSs and administrators. Differences in training received are also wide. In Africa, most front line extension workers still have only a secondary school diplomas.

Vijayargavan and Singh (1997) mentioned that extension organizations in developing countries face the major problems of professional incompetence and lack of motivation among their employees. Further, many of the agricultural extension departments of these countries do not have a well defined system of human resource management.

Extension organizations in developing countries do not have clearly defined job descriptions or job specifications for their extension personnel. The Training and Visit system of extension
considerably improved the preparation of job charts, work plans and
time-bound work for different categories of extension personnel.
However, the actual utility of job descriptions in extension
organizations is complicated by factors such as work over-load,
seasonally of extension, the range of cropping systems, and the
distribution of extension services over a large area (Hayward, 1990).

Studies analyzing the role of extension agents revealed that they
face work-related problems such as role ambiguity and lack of job
authority expertise, and accountability (Vijayargavan and Singh,
1989).

Careful recruitment is important and selection of the right kind
of extension personnel calls for looking for technical skills as well as
for commitment and willingness to educate rural people. An
appropriate selection system is essential to ensure the right selection.
The success of extension depends heavily upon selection of qualified
and motivated personnel.
Extension organizations in developing countries use two major
sources of recruitment: from outside and from within. Entry-level
position such as village extension workers and agricultural extension
officers are filled by outside recruitment, using the services of
government placement agencies. Other channels of recruitment are
advertisements, private placement agencies, professional search firms
and educational institute. In some countries farmers were recruited to
help extension agent (Adam 1980).

The policy of promoting or recruiting from within for middle
and top level position is advantageous as it promotes loyalty and
provide opportunities for existing extension staff to get high level of
positions. However, the greatest disadvantage is that it prevents the
lateral entry of talented extension personnel and promotes
complacency because seniority ensures promotion.
In general, extension organizations in developing countries use a simple knowledge test and a brief interview to select extension personnel. Vijayaragavan and Singh (1997) criticized this method of selection, as it is impossible to disqualify an effective candidate, because selecting extension personnel demands thorough, in-depth testing to cognitive and non-cognitive abilities.

**2.2.7 Training:**

The training of extension personnel contributes directly to the development of human resources within extension organizations. Hayward (1990) asserted those extension agents training should not be only in the technological aspects but also in human relations, problem solving, sensitivity towards disadvantaged groups, and the basic concepts of management.

**2.2.8 Agricultural research:**

One major trend related to agricultural extension in developing countries during the 1980s was a growing concern about its links with research. National policy makers and donor organizations identified weak links between extension and research as major factor limiting technological change and sought to improve those links through policy changes and institutional reorganization (World Bank, 1994).

Puncell and Anderson (1997) reviewed agricultural sector, institutions research and science entities in some African countries that carry out the bulk of agricultural research in Africa. As a carry-over from colonial period, many countries also have semipublic commodity boards with their own research capacity for export crops that are usually funded, at least partially, by cusses on marketable production. All but the smallest countries (such as Djibouti) have
universities with some agricultural research functions, but their contribution to research output is minimal with a few exceptions (for instance, Cote of Ivories, Uganda, and Zimbabwe). Funding constraints are common and is a serious issue in university system that limit not only research but also the systems ability to maintain an acceptable level of teaching capacity and curriculum development.

A variety of arrangements are in place for coordinating research agencies within National Agricultural Research Systems (NARSs).

Some countries use research councils, committee or commission (Burkina Faso, China, Kenya, Nigeria, Sudan, Ethiopia and Zambia); others have a singe semi-autonomous institute responsible for all non-university research (Burundi and Uganda); and the remainder tend to rely on the dominance of one institution to avoid unnecessary overlap in publicly funded research program (cote of Ivories, Madagascar, Rwanda, and Zimbabwe). World Bank projects has generally attempted to strengthen coordination arrangements.

The agricultural research staff in Africa has increased by sixth folds since 1960 with only 10% expatriate participation. Additionally the formal training of researchers has improved, two third of national agricultural researchers had advanced degrees. In Sudan 52% of the researchers hold Ph.D. Degrees. Among 20 countries two third of all Ph.D. researchers were found in three countries, Sudan, Nigeria and South Africa (Pardey et al. 1995).
CHAPTER TWO
LITERATURE REVIEW
SECTION THREE

AGRICULTURAL EXTENSION APPROACHES

2.3.1 Introduction:
The success of an agricultural extension programme tends to be directly related to the extent to which its approach fits the programme goals for which it was established (Axinn, 1988).

In practice extension organizations everywhere pursue the overall goals of technology transfer and human resources development, though the emphasis will differ. Within each organization there is a mix of objectives, and within countries there is often a mix of organizational patterns (UNDP, 1991).

Nagal (1997) grouped the agricultural extension approaches into two categories, I) General clientele approaches and II) Extension to select clientele approaches.

2.3.2 General clientele approaches:

2.3.2.1 Ministry-based general extension

Before or after independence organizing extension work under the wings of the ministry of agriculture seemed to be an ideal solution for many African and Asian governments. All options for reaching large numbers of clients and serving their needs in terms of quality information and assistance appeared to be open. The original colonial model combined research and extension within the same organization.
All important aspects of small-holder agriculture plant production, animal husbandry, and home economics—could be attended as the ministry established respective sections under its jurisdiction (Nagal, 1997).

Nagal (1997) mentioned additional two problems that face this approach, management and lack of control from below and said “Ministry extension employ thousands of persons working under a wide variety of circumstances. Decision-making and management are highly centralized and formalized”.

2.3.2.2 Training and visit system (T and V)

The training and visit system has been one of the most significant extension organizational developments in the last 5 decades. The system has been diffused very rapidly, first in South and South East Asia, where it has been shown to increase the effectiveness of agricultural extension in irrigated areas in a number of countries, thus contributing to rapid increases in food production, and later in Africa where it was not always so successful (Van den Ban and Hawkins 1996). This was because it was introduced under rainfed systems in extensive areas with lesser or mismanaged inputs and resources (Bannaga, 1989).

Hulame (1991) described the training and visit system as dominating the force of change in the Third World extension services in the 1970s and 1980s.

The training and visit approach of agricultural extension aims at building a professional extension service that is capable of assisting farmers in raising production and increasing incomes and providing appropriate support for agricultural development (Benor and Baxter 1984) explained the aim of the training and visit system as providing
management system, which can deliver timely and export know-how and ensure the coordination of research, training and extension.

The training and visit system is a set of managerial principles that are applied to agricultural extension (Robert 1989).

Van den Ban and Hawkins (1996) identified four main tasks of management of T and V systems as follows:

To develop a basic framework of the extension systems in which anybody knows what he is supposed to do; To organize the support necessary to enable all extension agents to do their work well; To supervise how well extension agents perform their task and, if necessary to help them perform this task better; To coordinate the extension work with organizations outside the extension service, such as research, provision of supplies and marketing. Originally the training and visit was initiated and supported by the World Bank.

According to Bannaga (1989) operationally, subject matter specialists provide fortnightly one-day training sessions to field extensionists. Each session focuses on a specific recommendation (the impact point) and its related skills to be applied directly at field level. The trained extension agents use their newly gained knowledge and skills by teaching them to select farmers (contact farmers) during the following fortnight, in a planned schedule which is known to the farmers. Problems and farmers questions are communicated to Subject Matter Specialists (SMSs) by extension agents in the next one-day training session. If (SMSs) do not have the answer or solution to a problem they refer it to researchers. The small number of contact
farmers covered by each extension agent are encouraged to transfer the information to other farmers, to multiply the coverage.

2.3.2.3 Integrated rural development approach

A horizontal approach, integrating different aspects such as agriculture, health, community development and education in one program. This approach has a broader view of the development process and its coordination under a single management system to get agricultural or rural development moving (Coombs and Ahmed 1974).

According to Rauch (1993), the integrated approaches are generally implemented in the form of large scale and foreign funded projects aiming at alleviating mass poverty in rural areas on the basis of simultaneous improvement in the utilization of natural resources and human potential.

Evaluation carried out more than a decade ago of the integrated rural development projects had revealed serious shortcomings in reaching the goal of mass poverty alleviation (World Bank 1997).

2.3.3 Extension to select clientele:

2.3.3.1 Commodity based extension

Next to the ministry operated general approach, commodity-based extension is run by governments, parastatals or private firms. Clients may be dispersed over a large area or closely connected as in the case of large centrally operated irrigation projects as in the Gezira scheme. Commodity based extension is predominant feature in many Francophone countries of Africa, but is also strong in other countries with commercial or export crops (Schultz, 1975, Nagel, 1997).

Nagel (1997) identified the advantages of the approach that, Objectives and targets can be clearly defined and the organizational structure kept simple. The focus on only one or two crops facilitates training of extension worker who are agent of the society. Control of agents and farmers is easy, because they are judged in terms of
defined targets. Nagel (1997) also identified disadvantages of this approach. The parastatal or group-processing and marketing organization often has monopoly power and extension activities may help, the company earns excessive profits at the farmers’ expense. If the company is poorly managed and is forced to inefficiency, then the comparative advantages of the crop can be affected and poor returns to farmer can result. The emphasis on one crop can sometimes mean that local needs are ignored and that insufficient attention is given to traditional food production.

2.3.3.2 Client-based and clients controlled extension

One way of dealing with the shortcomings of large extension systems has been to localize extension and utilize the self-help potential of rural groups often organized by outsiders. These decentralized approaches are in better positions to serve the needs of specific target groups notably those in disadvantaged positions. Close contact with their clients and intimate knowledge of their life situations are essential for the planning of problem-oriented extension activities. Local personalities are identified who take over leadership functions once the external non-governmental organization withdraws. This approach is a rather unique approach in that it has been practiced in Taiwan, where a large share of extension work is done through farmers’ associations. Organized at country provincial and township levels with membership covering 90 percent of Taiwanese farmers. Extension education is done by agents employed by the farmers’ association at the township level and financed largely by the farmers themselves (Lionberger and Chang, 1970; Axxin and Thorat, 1972; Nagel 1997).

UNDP (1991) mentioned that the impact of client-based approaches are seen at two levels. Directly, they provide benefits to their clients. The diversity and large number of small projects forbid a general statement on their effectiveness in terms of human resource development. It appears, however that their weakness lies more in the
technical field. Concerning the same issue, Nagel (1997) argued that the approach can reach only a very limited number of people. Apart from this, they perform an important role as organizational innovators. They have proved that participation can work in practice and that many farmers are highly competent partners in technology development.

2.3.4 The FAO participatory approach:

The participatory approach in agricultural extension assumes that farm people have much experience and wisdom regarding production of food from their land, but their levels of living could be improved by learning more of what is known outside. It further assumes that effective extension can not be achieved without the active participation of the farmers themselves, as well as the involvement of research and related services. That there is a reinforcing effect in group learning and group action, and that extension efficiency is gained by focusing on important points based on expressed needs of farmers, and by reaching more small farmers through their groups organizations instead of through individualized approaches. The purpose is to increase production and consumption and enhance the quality of life of rural people (FAO, 1987 and Chamber, et. al, 1989; FAO, 1990).

2.3.4.1 Farmer field schools (FFSs)

Is one of the agricultural extension participatory approaches, which is developed by FAO as part of the Integrated Pest Management programme (IPM). The central elements of the approach are the formation of self-help groups of the rural poor as the first step in a long-term institution building process. Groups are formed around
activities designed to satisfy the priority needs of the intended participants.

FFSs are excellent instruments in reaching farmers’ groups. They are creative and realistic in implementing extension and IPM philosophy, principles and practices.

They also strengthen linkages and interaction among farmers, researchers, specialist, managers and extensionists at various levels. In addition, they help in reducing costs, efforts and time in motivating farmers to improve their lives; they create a healthy environment, which encourages farmers and their trainers to be democratic and humanistic so that they can work together to challenge main constraints. As a result farmers became more organized, cooperative, independent, open-minded and communicative in expressing their needs and experiences. Farmers are motivated to actively participate in rural development.

FFSs graduates can offer practical models to other farmers and encourage them to establish their own schools.

The FFSs is a source of information in each village. They promote farmers to become experts in line with IPM principles. Proper farmers decision are at the base of IPM (Dabrowshi, 1997).
2.4.1 Introduction:

Sudan is a developing country and as is the case for most developing countries it depends on agriculture for its development. Agricultural extension services are provided by a variety of governmental departments and corporations. The Agricultural Extension Administration of the Ministry of Agriculture and Forestry is the main governmental body responsible for providing a widely diffused extension services. Other corporations offering extension services are the Sudan Gezira Board, the mechanized Farming Corporation, the Rahad Agricultural Corporation, New Halfa Corporation and White Nile pumps schemes. According to the Federal Agricultural Extension Administration, (1994) there are 456 extension staff members in Sudan whose services cover most of the states. While the extensionist ratio to farmers is 1 to 1000 farmers in intensive production areas, the ratio is 1 to 5000 farmers in Darfur and Kordofan. Still there are some areas uncovered by extension services, mostly in the Red Sea state and the places where rainfed traditional agriculture is predominant, in addition to some places in Kordofan and Northern Darfur.

Noah (undated) pointed out that prior to 1958 little had been done toward introducing modern farming methods and improved hand
tools to the bulk of farmers throughout the Sudan. In October 1957, the Sudan government on the invitation of US government agreed that the agency of the US government known now as Agency for International Development AID sent a mission to Sudan to help with country’s many and varied agricultural problems. Early in 1958 a program of US economic and technical assistance to Sudan based on the Mutual Security Act was established. The extension program was among the early efforts of the mission where the department of agriculture was provided with technicians (who worked in close collaboration with Sudanese counterparts) and educational facilities.

This first provisional extension unit was setup in the second half of 1959 and operation during those early stages was limited to district level (Abdel Rahman, 1972:1). It is argued that extension system, not being originally a national demand is viewed for a long time as strange activity and was paced at the bottom of the government priorities for long time. The major consequence of such situation were: a) that extension system remained as low priority, and b) ineffective delivery system (Ahmed, 1994).

2.4.2 Previous Strategies and Approaches:

Noah (undated) traced the first steps of organization of agricultural extension in Sudan as follows: One field office had been established in each of the administrative areas namely, Equatoria, Kordofan, Upper Nile and Blue Nile provinces. The training of Sudanese citizens who were to primarily be responsible for developing agricultural extension in the country was initiated. For this purpose an extension, audio-visual training program at Shambat Institute of Agriculture was established, the graduates constitute the greater proportion of extension personnel.
Step three was to screen several local agriculturists who would communicate extension methods and ideas to the people at the village level. Most of these groups are graduates of the intermediate or secondary agricultural schools. Then demonstration farms were established in each development area for the purpose of showing the farmers how to improve upon their methods of farming. Farmers were allowed to frequent visits. These demonstrations were under the guidance of the extension staff.

Orientation of the inspectors of agriculture to the point that they take the initiative in program planning and organizing advisory councils for the purpose of delineating responsibilities and making necessary program recommendations to the Ministry of Agricultural for action.

The last step was the development of an effective information center to provide information and teaching aids to the agents in the field.

Barghouti (1976) described the extension approach used by the extension services in Sudan by noting, “Reaching individual farmers has been the main approach through which the field worker dispenses his efforts haphazardly to limited numbers of farmers in his area”.

The demonstration farm was the main method used by extension agents and a number of demonstration farms in different development area were established. A study by (Mataug, 1981) found that by using the extension demonstration farms the majority of the extension agents (57.7%), were trying to reach the local and community adoption leaders and (31.2%) of the extension agents were trying to reach the majority and the laggard and only (11.2%) were trying to reach the innovators.

2.4.3 Agricultural extension staff:

At the beginning of the agricultural extension work in Sudan, government realized the need for trained staff. According to the Agricultural Extension and Education Department (1964).

In addition to university graduates staff there were field inspectors at field level who do the work of extensionists. In the Gezira scheme there are about 400 agricultural inspectors, only 17 have received substantial in agricultural training at all. These inspectors are responsible for providing specific services to the farmers (loans, seeds, fertilizer and insecticides). Many of these inspectors were hired because of their long association with the
communities in which they serve. Such as middle aged teachers, employees, and other civil servant were recruited to become agricultural extension and this arrangement, as identified by Abd ElRahman (1972) and Barghut (1976) is the main constraint that hindered agricultural extension work.

The university graduate extension staff multiplied 12 times.

Tables 1, 2, 3. Despite the increase in the number of staff, a big staff shortage had been identified. It was found that shortages existed in all educational levels and in all states of the Sudan, the average percentage of shortage for all Sudan was estimated as 68.2 percent (Federal Extension Administration, 1994).

Robison (1996) criticized the training of extension staff in agricultural development projects, in that more emphasis is placed on the development of agricultural workers’ communication skills through investment of sophisticated equipment and training packages, rather than on the through development of the agents’ practical agricultural skills.

Table 2.4.1 Agricultural extension personnel from 1970 to 1988

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of the extension personnel</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td>90</td>
</tr>
<tr>
<td>1975</td>
<td>176</td>
</tr>
<tr>
<td>1980</td>
<td>243</td>
</tr>
<tr>
<td>1985</td>
<td>372</td>
</tr>
<tr>
<td>1988</td>
<td>456</td>
</tr>
<tr>
<td>Total</td>
<td>1337</td>
</tr>
</tbody>
</table>


Table 2.4.2 Distribution of extension personnel in Sudan by level of education in 1994.

<table>
<thead>
<tr>
<th>Education level</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secondary school diploma</td>
<td>82</td>
</tr>
</tbody>
</table>
Intermediate level qualification | 55  
University degree or equivalent | 109  
Post graduate degree | 19  
Total | 315  

Source: Compiled from Federal Extension administration (1994)

Table 2.4.3 Distribution of Agricultural Extension Personnel By State/ projects and educational level, 1994

<table>
<thead>
<tr>
<th>State/Project</th>
<th>Post Graduate</th>
<th>University Degree</th>
<th>Intermediate level</th>
<th>Secondary school Diploma</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern</td>
<td>3</td>
<td>9</td>
<td>2</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>New Halfa</td>
<td>2</td>
<td>8</td>
<td>3</td>
<td>13</td>
<td>26</td>
</tr>
<tr>
<td>Central</td>
<td>5</td>
<td>35</td>
<td>16</td>
<td>8</td>
<td>64</td>
</tr>
<tr>
<td>Elrahad</td>
<td>2</td>
<td>23</td>
<td>-</td>
<td>-</td>
<td>25</td>
</tr>
<tr>
<td>Blue Bile</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>Kordfan</td>
<td>3</td>
<td>25</td>
<td>12</td>
<td>16</td>
<td>56</td>
</tr>
<tr>
<td>Northern</td>
<td>-</td>
<td>30</td>
<td>14</td>
<td>27</td>
<td>71</td>
</tr>
<tr>
<td>Khartoum</td>
<td>3</td>
<td>21</td>
<td>4</td>
<td>15</td>
<td>43</td>
</tr>
<tr>
<td>Darfur</td>
<td>1</td>
<td>5</td>
<td>4</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td>19</td>
<td>159</td>
<td>55</td>
<td>82</td>
<td>315</td>
</tr>
</tbody>
</table>


2.4.4 Agricultural Extension Through Inspectorate System

The evolution of the inspectorate system in Sudan has been described as follows:

Creation of the agricultural inspectors’ job is traced to the establishment of the irrigated scheme, in Sudan, when the colonial administration recruited intermediate school graduates and primary school teachers to carry out the field responsibilities with farmers such as distribution of land, implementation of agricultural laws, collection of taxes and some technical advice.

The inspectors used oppression methods to deal with farmers (police methods). The inspectors houses are located far away from the farmers, the result is a communication gap between the inspectors and the farmers. After the independence this method was not changed despite the recruitment of agricultural university graduates. The job is still performed as it was created during the colonial period (Idris, 1975; Noah (undated) and Barghuti, 1976).
Noah (undated) argued that the process of orientation of agricultural inspectors to work as extension agents was intended lead to change of attitudes of inspectors from the police approach to the one compatible with preserving human dignity, promotion of mutual ties, and motivation. In addition, he argued further that the routine of sending monthly reports by the inspectors in the provinces to the central office in Khartoum would give them the opportunity to become further acquainted with the nature of extension work. Barghouti (1976) and Robison (1996) criticized the supervision of extension agents by the inspector whose work is historically known to represent the regulatory and not the educational aspect of the ministry. They stressed that this strategy has engulfed the work of extension personnel and reduced the efficiency of their program.

2.4.5 Agricultural research in Sudan:
The history of agricultural research activities in Sudan dates back to 1902 with the establishment of experimental cotton farms at Shendi, on the main Nile, and at El Kamlin, on the Blue Nile. A year latter, two more experimental farms were started at Rumbek. In 1904 the Department of Agriculture established Shambat Research Farm where some botanic and agronomic work was carried out (Idriss, 1975).

During the first seven years at Shambat, cotton growing was shown to be a financially viable proposition following the commercial success of the first field trials based on Shambat’s findings and conducted on 60 ha of irrigated land at Tayiba in 1910 – 1911. The Gezira scheme which ultimately became the largest single farm in the world, was started. The establishment of Sudan’s major agricultural research station in Wad Madani at the heart of the Gezira scheme followed soon after the first cotton field trails and this has remained the headquarters of agricultural research operations since 1918, the year of its official opening. In keeping with its integral role in the agricultural development conducted between two world wars that concentrated almost exclusively on Gazira, the installation in Wad Madani became among the first in Africa. The need to investigate other regions resulted in the establishment of two other centers at Kadugli in 1935 and at Yambio in 1948 (Robsion, 1996).

Just prior to independence the need to diversity and to investigate alternative systems outside the Gazira scheme, but within the existing infrastructure, prompted the establishment in 1952 of the
Kenana research station at Toze, with mandate to investigate rain-fed agricultural systems.

By the beginning of the 1960s, are result of the Post-independence developmental emphasis on irrigated agriculture, research stations and sub-station were created at Hudeba 1962, Khashm Elgirba 1960, El Geneid 1963, Sennar 1963 and Matug 1963, also in 1963 the Kenana station was moved to Abu Neama, where water for irrigation was more readily available. With the temporary closure of Yambio in 1964 then Agricultural Research Division of the Ministry of Agriculture, Food and Natural Resources, which became the Agricultural Research Corporation in 1967. Also it concentrated almost all of its activities in and around the Gezira scheme, and at Hudieba, a site similar to that of Gezira at the confluence of the Nile and Atra rivers.

In 1975, as part of aratimalization process the semi-autonomous Agricultural Research Corporation (ARC) assumed responsibilities for the reopened Yambio Research Station; Forestry Research Institute at Soba, the Food Research Center in Khartoum North and Wild life Research Center in Khartoum. Shendi Research Station was established in 1976 to conduct research in fruit, vegetables and food legumes. In 1977 the Rahad Research Station was established given emphasis to the evaluation and selection of suitable agricultural machinery.

In Sudan a variety of non ARC or independent bodies also undertook agricultural research. These include the Universities of Khartoum, Gezira and Juba and research units in various developmental projects (Idriss, 1975; Saeed et al. 1986 and Robinson, 1996).

2.4.6 Research and extension linkage

There was no direct linkage between the Agricultural Research Corporation and the Agricultural Extension and Education Department. The channels for dissemination of research findings achieved to different production administrations, and hence to farmers were in the form of:

- Annual agricultural meeting.
- Cotton varieties committee.
- Crop agronomy committee.
- Pest and disease committee.
- Crop varieties committee.
- The technical committee for follow-up of agricultural operations.
- Annual reports.
- Specialized workshops and seminars for solving agricultural production problems.
- Visit to demonstration fields.

The different committees included all the professionals concerned in the planning, execution, and administration of agricultural production. The committee met annually to study and discuss achievements of the previous agricultural season. They recommend some scientific solutions for the problems tackled through research (Saeed, et al.; Jamal and Eltahir, 1986).

Barghouti (1976) described the lack of linkage between research and extension in three points.
The first point is that, the extension plans its programs with marginal involvement or consultation with the staff of research station.
The second point is the joint training programs between agricultural research station and agricultural extension education department are rare.
The last point is, the establishment of extension units is carried out without utilizing the facilities and resources available at research stations.

Robinson (1996) concluded that the weak structure and poor communication between education, training, research, and extension have constituted factors contributing to the noted lack of success of agricultural projects. He stressed further that the difference between farmers and planners is much more likely to be the cause of lack of success of agricultural projects in Sudan.

2.4.7 Factors Limiting Agricultural Extension Work in Sudan
Abdel Rahman (1972) identified five factors that limited the coverage of agricultural extension in Sudan as follows:
- Lack of a plan for the operation of the national extension organization.
- Shortage of trained staff.
- Inadequate financing at both central and provisional levels.
- Insufficient transportation facilities.
- Unavailability of equipment and materials needed to conduct scientific extension operation.

  Barghouti (1976) analyzed the handicaps facing the extension services as follows:
- Variations in farmer’s population posed a serious handicap when planning a national agricultural extension strategy.
- Governmental attention has for a long time been focused on serving the commercial sector of agriculture rather than improvement of the standard of living of small farmers. The traditional sector of agriculture especially in the rain-fed areas of the western provinces, has hardly received any extension services.
- Extension officers and personnel have been assigned to serve in provinces and districts without specific realistic and practical targets to achieve.
- The formal and functional relationships between the agricultural research corporation and the agricultural extension and education department are week.
2.5.1 Introduction:

Agricultural extension is a very important component in the agricultural production process. Together with the existence of basic research results, it promotes the agricultural development. Extension work as an educational activity aims to transfer the new innovations and technology to small farmers. It focuses on the rural families in rural communities and help them to improve their life. Also extension work helps the farmers in marketing their products. It teaches them the new methods and techniques, to prepare their products for the market competition. This type of extension work is called marketing extension.

Although, according to the Arab Organization for Agricultural Development (AOAD) (1999) in most Arab countries, agricultural extension programs emphasize tackling problems related to agricultural production, and introducing innovations and new technologies to alleviate those problems and constrains, their attention to the marketing is still very weak.

2.5.1.1 The Concept of Marketing:

*The concept is defined as the series of activities involved in making available services and information which influence the desired level of production relative to market requirements, and the movement of product from the point of production to the point of consumption (FAO, 2000).*
This definition prescribes the services, which should be covered by the extension officer, such as providing information and advice. In this context the role of the marketing extension officer includes collection, evaluation and dissemination of market information; assistance in the planning and scheduling of production; securing the market for producers. For example through contracts with buyers; advice on the best post- harvest practices; coordination of inputs, transport, storage, credit and post-harvest facilities.

The key activity of an extension officer, is the commercialization of the rural economy. This involves finding out that the customer wants and helps to set up the production/marketing system, which satisfies that demand and maximizes the income of rural areas.

2.5.2 The Role and Place of Agricultural Marketing in Agricultural and Rural Development:

Agricultural marketing has an essential role to play in agricultural and rural development. The strong relation between agricultural production and marketing makes it imperative to develop the two together, other wise all efforts to increase agricultural production would be frustrated as proven in many countries (Abdallah, 1989). The marketing system can often make or break the development plans for agriculture and it may be especially crucial during the early years of the development program (Collins, et. al, 1963). Objectives relating to increasing farmer’s income, reducing disparities between urban and rural areas, improving nutrition, improving the quality standard have greater chance in the presence of adequate marketing system.

Furthermore, agricultural marketing contributes significantly in channeling the net capital surplus out of the agricultural sector for
general economic development, in integrating the farming community into the market economy. Also in contributing to the growth of the primary and secondary sectors, in modernizing traditional areas and in improving the living condition of farmers.

Agricultural marketing has a dynamic role to play assisting the realization of the major objectives of agriculture sector such as economic growth, income distribution, employment, improve nutrition and food security. Moreover, agricultural marketing is a good medium for communicating new ideas, creating new demands, developing managerial talents, and introducing innovations.

The relevant information and knowledge about agricultural marketing in most of Near East countries is inadequate. Little research is being carried out about marketing and when it exists it is of descriptive nature. This explain why it is has been difficult to identify accurately the problems and requirements of the marketing system and design appropriate improvement measures (Abdallah, 1989).

2.5.3 **Marketing Orientation:**

While many extension programs are using some marketing tools, they are not necessarily market oriented. Instead, many extension professionals are pre-occupied with executing their program, with efficiency, or with convincing clients to select extension's current programs. Extension professionals must recognize that an emphasis on programming, production, and selling is only part of the task of becoming truly marketing-oriented.

As applied to extension, marketing-orientation is based on three major propositions: client orientation, coordination of all client-related activities, and goal direction.
2.5.3.1 Client-Orientation:

Meeting the wants and needs of consumers is the key to a marketing orientation. Extension professionals must shift from an internal organizational perspective to the client's viewpoint. Successful marketing of extension's programs requires a complete understanding of extension's clients—their needs, attitudes, and buying behavior. Thus, a marketing orientation holds that the main task of the cooperative extension system is to determine the needs and wants of target clientele groups and to satisfy them through the design, communication, pricing, and delivery of appropriate and competitively viable programs and services (Kotler & Fox, 1985).

2.5.3.2 Coordination:

There must be close cooperation among all components of an Extension organization. All participants in policy and strategy formulation, as well as programming, must take a market-oriented view of extension's clients and other constituencies. Extension must take place to become more responsive to its clients, such as conducting studies of client satisfaction and of the clients’ needs and preferences, as well as developing appropriate ways to respond to complaints and suggestions. Furthermore, marketing needs to be introduced to various groups in an extension organization. Internal marketing training should first be made available to top extension administrators and advisory groups because their understanding and support are essential if marketing is to be successfully applied by extension (Drucker, 1973).

2.5.3.3 Goal Orientation:
A marketing-orientation stresses that the only way extension can achieve its own goals, is by satisfying the needs of its clients. This may require the development of special educational programs and activities for local community leaders and public officials. Thus the main task of extension is to determine the needs, wants, and interests.

2.5.4 Marketing Extension Techniques:

According to FAO (2000) there are many marketing extension techniques

2.5.4.1 Farmer teaches farmers:

A successful farmer explains to a group of farmers his production and marketing practices. The meeting is most effective on the farmer own farm.

2.5.4.2 Demonstrations:

Practical demonstration of techniques such as harvesting, cleaning, grading and packing, preferably taking place on a farm. Prepared samples, which demonstrate the differences over time of different handling practices can be effective, as are samples of competing products and photographs.

2.5.4.3 Talks and seminars:

Possible topics include market possibilities successful case studies, post- harvest techniques and market- oriented production techniques. Buyers and middlemen should be involved to talk.

2.5.4.4 Problem solving techniques:

The farmers group is encouraged to identity its own major problems. The problem- solving can be tackled systematically, by calling in specialists individually to advise the group or to form a panel to answer farmers’ questions. Alternatively, the group might be encouraged to
decide their own solutions which they implement themselves collectively.

2.5.4.5 Study tours:

Farmers are taken on a study tour to make their own contacts and to see the market for themselves. They visit processing centers and observe how their products withstand transportation. Farmers visit farmers in another area to exchange experiences can alone transform grower’s views on production and marketing.

2.5.4.6 Written information:

Fact sheets are prepared and distributed. These can identify potential trading partners or provide technical information on production and post-harvest techniques.

2.5.4.7 Market news services:

Establishing a market news service which provides regular, reliable, relevant and timely information. This may be in the form of a news sheet or a radio bulletin.

2.5.5 Problems and Constraints of Agricultural Marketing:

Agricultural marketing in developing countries faces a multitude of problems and costarring that impede its development. The intensity of the problem varies from one country to another depending on the level of development and the attention given to agricultural marketing. Identification and careful analysis of the effects and interrelation of the major problems and constrains should always be the launching pad for effective and realistic formulation of agricultural marketing, policies programs and plans (Abdallah, 1989).

2.5.5.1 Technical Constraints:

Comprise weaknesses or lack of marketing research, marketing extension, and plant protection services, marketing services and credit services. Technical constraints also included inadequacy of collection and wholesale markets, and deficiency of the agricultural processing sector to absorb and utilize the production surplus specially of milk and other animal products (AOAD, 1999).
There is a general lack of awareness on the importance of agricultural marketing. The public image of agricultural marketing is generally negative. Marketing without much objective analysis is considered unproductive (Abdallah, 1989).

According to Bannaga (1998) technical constraints in Sudan are due to weak budgets, which are frequently reduced during the financial year and the slowness of replenishment and untimely release funds.

Finance for agricultural marketing development is a major constraint particularly to small-scale private institutions. The agricultural credit institutions never provide the much-needed marketing credit farmers. All these reduce access to the operational inputs, retarded the mobility of staff and weaken the incentives to attract and sustain qualified and experienced staff.

Shortage of well-trained and experienced marketing personnel at all levels is among the major constraints to marketing development. This is why most country studies indicated shortages in technical staffing and few staff who are spear heading the activities, are doing them without proper or adequate qualifications and without proper technical back stopping from marketing research institutions because such institutions are not available.

2.5.5.2 Economic constrains:

Included the relatively low net returns obtained from agricultural products, lack of incentives of those working in the markets of agricultural sector, in general, and in agricultural marketing in particular (AOAD, 1999).

According to Abdallah (1989) agricultural marketing is greatly constrained by the conditions of agricultural production. Agricultural production is seasonal, uncertain and vulnerable to changes in weather conditions. Marketing is complicated by the diverse nature of agricultural produce and their non-uniformity and perishability.

Agricultural marketing is characterized by price instability because of variation in supplies accentuated by lack of proper storage facilities and sometimes by speculative activities of some of marketing institutions.

Agricultural marketing in many countries is also constrained by the problem of high post harvest food losses resulting from poor handling practices, shortage of proper physical facilities particularly storage and transportation and weakness of facilitating services relating to planning, information, research, extension and quality standards (Abdallah, 1989).
Economic constraints are the result of government policies and shortage of funds because of canceling the support to all the agricultural services.

2.5.5.3 Institutional and organizational problems:
Included the lack of institutions concerned with planning, and management of agricultural marketing activities in most Arab countries including Sudan, and lack of coordination between these institutions if available in some countries. This is in addition to deficiency of financial facilities, technical and managerial personal and marketing expertise in most institutions operating infield of agricultural marketing (AOAD, 1999).

2.5.6 Marketing Policy Issues:
Public policy refers to statutes, laws, rules, regulations, directives and actions made by the state for organization and management of economy. The types of public policy are determined by a number of interrelated factors with varying degrees of influence such as cultural and social structures, historical factors, economic and financial situation and overall development objectives and strategies. Public policy can be broadly divided according to its functions into regulatory, facilitative and interventionist policies. The structure and the performance of a marketing system is greatly shaped and influenced by the prevailing public policy.

Abdallah (1989) categorize the objectives of agricultural marketing policy in direct and indirect, the direct objective is to improve the efficiency of the system to the satisfaction of its consumers, producers, and market intermediaries. A marketing system could be described as efficient if resources are allocated in accordance to comparative advantage and scarcity, if the price different through time and space reflect respectively full cost of storage and transpiration and if marketing margins and cost reflect the cost providing the services.

The indirect objective is to use of the marketing system in implementing or supporting other policies such as protecting social groups, equity considerations and control of foreign exchange. Underlying these objectives are economical, social and political aims of increasing production enhancing farmers income reducing losses and marketing costs and optimizing allocation of resources…etc. The marketing policies should satisfy certain minimum requirements if they are to serve their objective effectively and these requirement
are good background information and careful analysis of situation, consistency, acceptability and operationally.

2.5.6.1 Marketing institutions:
There is no general agreement in developing countries on which government, private, co-operatives or a combination all these as marketing organization, satisfy the different economic conditions, social and political realities of each country.

The private marketing enterprise system has generally bad public image in many countries. It is accused of exploitation, monopolistic practices and wastefulness. The large numbers of middlemen in terms of number and kinds and multiplicity of stages of distributive channels have been frequently criticized. However, the exponents of privatization believe that private sector could play a vital in the improvement of the marketing system if the necessary conducive conditions are created to provide it with free choice and maximum participation and effective contribution (Abdallah, 1989).

The role of public enterprises in marketing has been under careful scrutiny by many governments in the Region interested donor agencies. The public enterprises are criticized of being poorly organized, wasteful and inefficient. They are also accused in providing unsatisfactory and poor services at high cost.

The co-operatives have always been a controversial subject in the Region and many countries ambivalent attitude towards them. Co-operatives are voluntary organizations based on the principles of participatory democracy. Agricultural marketing co-operatives is another policy option for marketing improvement, and therefore improvements could be effectively introduced by encouraging farmers group action.

2.5.6.2 Technology:
According to Abdallah (1989) a clear policy on the application of technology should be formulated. Absence of such policies in some countries have led to importation of technology such as mechanical sorting, packing plants, storage unsuited to local conditions which complicated the situation and resulted in higher marketing costs of these technologies.

2.5.6.3 Market Finance:
Limited access of farmers and market intermediaries to formal credit is among the major constraints to efficient marketing in most
developing countries (Abdallah, 1989). Agricultural credit institutions do not generally provide the much needed marketing loans to farmers who need short term finance to increase their holding power immediately after harvest when prices are usually at their lowest level and medium term loans; to introduce marketing improvements in transport, packing, grading and storage.

CHAPTER THREE
METHODOLOGY

3.1 Area of the Study:

3.1.1 General overview of Agriculture in Kordofan:

3.1.1.1 North Kordofan:

North Kordofan agriculture is an integral part of the traditional rain fed system practiced in 3 types of soils, namely:

1. clay/sandy soils lying to the south.
2. Qoz soils lying to the north.
3. “Gardod” soils.

Another characteristic of the region is the low and variable rainfall. The average annual rainfall is 317mm/annum (Eldukheiry, 1997). This rainfall is highly variable, and hence, this variation combined with the available types of soils in the region limit the types of crops that can be cultivated.

Moreover, the characteristics of agriculture in this region are also influenced by the socio-economic environment. The region has low
population density, and farmers use simple hand tools and family-based agricultural production.

The agriculture production is labor-intensive and the use of chemical inputs is limited to small amounts of pesticide and fungicides by some farmers.

The cropping pattern in this region consist of a mixture of subsistence crops (millet, sorghum, water melon and some cow pea) grown in conjunction with cash crops (sesame and groundnut).

Groundnut is the second most important cash crop grown in the area this crop is more intensively grown in the south and west of region than in the north and east (Eldeemy, 1995).

About half of the farmers in the region grow this crop in their fields. It can be noticed that owned farms grow more of this crop than rented and shared farms. 79% of owned farms in the region are planted to this crop.

3.1.1.2 South Kordofan:

South Kordofan has a variety of fertile soils, ranging from heavy black and cracking soils to the lighter clay types and sandy loam’s fertile soils.

According to the heterogeneity of soil in the area, different categories of vegetation can be distinguished (Bello, 1998).

Rain-fall starts in May and continues until October with annual total average of 700 mm, relative humidity reach over 90% during August and minimum of about 26% in March (ARS, 1997a).

Agriculture is considered the major economic activity for the majority of the population in the area. Different cash and subsistence crops are cultivated. Cash crops are sorghum, sesame, cotton, groundnut and rosette, which are cultivated in the big farms, while the
subsistence crops are early maturing varieties of sorghum, maize, millet, cow peas and a variety of vegetables which are planted in jubrakas (back-yard gardens cultivated by women).

The main agricultural production systems in the area are:

1. **Sedentary Production System**: the majority of the population practices this system. In this system households raise sorghum as the primary and staple food crop, which is intercropped with either sesame or cowpea.

2. **Transhumance Production System**: household in this system generate virtually all their income through the sale of livestock and livestock products. Crop production plays a secondary role in this system. However, sorghum, sesame, cotton, millet and groundnut are most common.

3. **Mechanized Production System**: started in 1968 in the clay plains in Habila area and expanded during the period of 1970-80 to cover an area of one million feddans. According to farm size this system comprises:

   I) **Mechanized Small Holder Tenant System**: In this system the household is still the principal production unit growing sorghum and cotton in 15 feddans plots.

   II) **Mechanized Large Scale Farming**: The area of farms in this system is ranging between 1000-1500 feddans. The main crops cultivated are sorghum and sesame (ARS, 1997a).

Despite the fact that the majority of groundnut comes from West kordofan, North Kordofan and South Kordofan were chosen as the area of the study, because in these two areas there are clear factors affecting aflatoxin contamination of groundnut. In the North, the
drought stress caused by lack and variability of rainfall and in the South high humidity after harvest is a major causative factor.

3.2 Method of data collection:

This study uses both secondary and primary data. The secondary data include reviewing the literature and available secondary data set from various sources. The primary data of this study was collected through structured questionnaires. Two surveys one in North Kordofan and the other in South Kordofan were carried out at harvest time in 2003 to collect primary data.

3.3 Sample Size:

How the number of respondents or the number of subjects observed in a particular sample is determined, is actually one of the simplest decisions within the research process. However, because formulae are used, the method often appears to be very complicated. In reality, a sample size is usually selected between what is theoretically perfect and what is practically feasible.

Computing sample size using the confidence interval approach:

In order to calculate the proper sample size for a survey, only three factors need be considered: (1) the amount of variability believed to be in the population, (2) the desired accuracy, and (3) the level of confidence required in the estimates of the population values.

Determining sample size using a percentage:

There is a formula that includes the three considerations. When determining a percentage the formula is as follow

\[ n = \frac{z^2 (pq)}{e^2} \]
n = the sample size

z = standard error associated with the chosen level of confidence

p = estimated variability in the population

q = (100-p)

e = acceptable error

This formula is used when focusing on some nominally scaled question in the survey (Burns and Bush, 1995).

It is assumed that there is great expected variability 50% and ± 10% accuracy is needed at 95% level of confidence and 95% level translate to z of 1.96.

\[ n = \frac{z^2 (pq)}{e^2} \]

\[ 1.96^2 \frac{(50 \times 50)}{10^2} = 100 \]

The sample size calculated from the formula, was approximately equal to one hundred. The sample size in the study was increased to one hundred and twenty, because of availability of farmers in the market and the greater the sample size the less the error.

Because there were not records about the number of groundnut farmers in North and South Kordofan a criterion of proportion of average production between North and South from the table (3.1) was used to divide the sample size between the two areas.

**Table No.3.1 Groundnut Production in the Sudan season 91/92 – season 2002/2003. Production in (000) M.TS**

<table>
<thead>
<tr>
<th></th>
<th>91 / 92</th>
<th>92 / 93</th>
<th>93 / 94</th>
<th>94 / 95</th>
<th>95 / 96</th>
<th>96 / 97</th>
<th>97 / 98</th>
<th>98 / 000</th>
<th>99 / 001</th>
<th>000 / 002</th>
<th>001 / 003</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>21</td>
<td>49</td>
<td>18</td>
<td>17</td>
<td>10</td>
<td>3</td>
<td>6</td>
<td>18</td>
<td>5</td>
<td>14</td>
<td>21</td>
</tr>
</tbody>
</table>
The average production of groundnut in North Kordofan for the last 12 years was 15000 Metric Tons (M.Ts,) and for South kordofan was 25000 M.Ts. Although the production methods were traditional in the both areas the average production of the farmers in South Kordofan exceeded that of North Kordofan, this most probably due to increased number of groundnut farmers in South Kordofan. For this reason the proportion between North and South of 3:5 was used as indicator to differentiate between sample size in North and South Kordofan. When this proportion was used the sample size in North was 45 and in the south was 75 to have total sample size of 120. The sample size of North Kordofan was 43 and of South Kordofan was 77.

3.4 Sampling Technique:

Systematic sampling is one of the most prevalent types of sampling techniques used instead of simple random sampling. In order to use systematic sampling, it is necessary to obtain a listing of the population just as in case of simple random sampling. However, it is not necessary to transcribe names, numbers, or any other designations into slips of paper or computer file.

Two weekly regular markets, one in North Kordofan and the other in South Kordofan, were used to choose the sample from them. The markets are held once a week in on open area in a centrally located village to serve a cluster of villages each not more than half-a-day walk from the center village.
Sometimes each of these cluster villages (usually between 5 and 10) has its own weekly market. In North Kordofan weekly market farmers who were chosen, were from the following villages. Kazgail, Elmulbas, Ubo Naanaa, Elgefail, Eldago, Khortagat, and Elmassan. In South Kordofan the farmers visited the weekly regular market from Elfarshia, Eldago, Elsongokia, Elkarko, Elhemidia, Kangar, Elgragil, Um siada, Elhigerat, and Elsuiab village.

In the two markets there were no records to estimate the exact number of farmers who visit them weekly. The farmers estimated that about 300 farmers came to the markets weekly. However, instead of the farmers’ estimates, the researcher decided to use a skip interval, which is calculated by dividing the number of names on the list by the sample size (Burns and Bush, 1995).

\[
\text{Skip interval} = \frac{\text{population list}}{\text{Sample size}}
\]

To calculate the skip interval in North Kordofan 300 (the number of farmers in the market) was divided by 45 (the sample size from North Kordofan), which resulted in a skip interval of 7. Because there is no list of farmers the method of randomization used was from every 7 farmers coming to the market farmer number 3 was chosen as random start.

In South Kordofan the skip interval was equal 4, (300/75) where from every 4 farmers coming to the market, farmer number 2 was selected as a random start. The process continued till the required sample size from North and South Kordofan was finished.

3.5 Analytical techniques:
Descriptive analysis, chi-square, and correlation coefficient were used to analyze the data of the study.

3.5.1 Frequency Distribution:
A frequency distribution is a tabulation of the number of times that each different value appears in particular frequencies, which themselves are raw counts, and normally these frequencies are converted into percentages for ease of comparison (Burns and Bush, 1995).

The total number of observations arrives at the conversion very simply through a quick division of the frequency for each value for all of the values, resulting in a percent.

3.5.2 Chi square analysis:
Chi-square was used to test the association between nominally scaled variables in the questionnaire. Chi square analysis is the examination of frequencies for two nominally scaled variables in a cross-tabulation table to determine whether or not the variables have a nonmonotonic relationship. The formal procedure for chi square analysis begins when the researcher formulates a statistical null hypothesis that the two variables under investigation are not associated. Actually it is not necessary to state this hypothesis in a formal sense, for chi square analysis always implicitly takes this hypothesis into account (Mansfield, 1994).

3.5.3 Correlation coefficient:
Correlation coefficient analysis helps to study the relationship between the socio-economic characteristics of the groundnut farmers in Kordofan.

The correlation coefficient is an index number, constrained to fall between the range of −1 to +1, which communicates both the strength and the direction of association between two variables. The amount of association between two variables is communicated by the absolute size of the correlation coefficient while its sign communicates the direction of the association (Burns and Bush, 1995).
CHAPTER FOUR
RESULT AND DISCUSSION
SOCIO-ECONOMIC CHARACTERISTICS OF GROUNDNUT PRODUCERS IN KORDOFAN

4.1 Introduction:

This chapter will discuss the socio-economic characteristics of groundnut producer, and their relationship with the degree of awareness of aflatoxin among them. Also it will discuss the effects of socio-economic characteristics on the adoption of new practices and acceptance of extension training course to improve their groundnut quality.

The socio-economic characteristics, which were studied included producer age, farm size, type of occupations, education level and sex. Each characteristic was studied separately and expressed as a percent of the total number of producers, and the relationship between them also was studied.

4.2 Producer Age:

Producers were interviewed as to their ages and a finding is presented in (table 4.1). 78.3% of the producers are 50 years old and less. The other group about 21.7% is more than 50 years old.

4.3 Farm size:

Groundnut growers were asked about the areas of land cultivated. The result is presented in (table 4.2). 60.8 % of the producer in Kordofan cultivate less than 5 feddan. 22.5% of the producer cultivate 5-10 feddans and only 16.7% cultivate more than 10 feddans.

4.4 Type of occupation:
The agriculture is the main occupation for 83.3% of groundnut farmers in Kordofan. Only 16.7% of them have another activities beside groundnut cultivation (table 4.3). The other activities those groundnut producer practices are such as hired laborer, employee, merchant and other income generating activities by women.

**Table 4.1 Frequency distribution of the respondents by their age.**

<table>
<thead>
<tr>
<th>Age</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 30</td>
<td>20</td>
<td>16.7</td>
</tr>
<tr>
<td>30-40</td>
<td>45</td>
<td>37.5</td>
</tr>
<tr>
<td>41-50</td>
<td>29</td>
<td>24.2</td>
</tr>
<tr>
<td>51-60</td>
<td>18</td>
<td>15</td>
</tr>
<tr>
<td>More than 60</td>
<td>8</td>
<td>6.7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>120</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Source: Field Survey October 2003.

**Table 4.2 Frequency distribution of the respondents by farm size.**

<table>
<thead>
<tr>
<th>Area in feddan</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 5</td>
<td>73</td>
<td>60.8</td>
</tr>
<tr>
<td>5-10</td>
<td>27</td>
<td>22.5</td>
</tr>
<tr>
<td>More than 10</td>
<td>20</td>
<td>16.7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>120</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Source: Field Survey October 2003.

**Table 4.3 Frequency distribution of respondents by the agriculture as a main occupation.**

<table>
<thead>
<tr>
<th>Response</th>
<th>Frequency</th>
<th>percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>100</td>
<td>83.3</td>
</tr>
<tr>
<td>No</td>
<td>20</td>
<td>16.7</td>
</tr>
</tbody>
</table>
4.5 Educational level:

The major benefits of education are directly related to the higher productivity of the individuals who have received it. Education raises productivity through various means. A better-educated person absorbs information after he applies unfamiliar inputs and new processes more effectively.

Lockhead, Jamison and Lau (1980) found that, extension services have also contributed to agricultural productivity. However, farmers with some formal education were apt to use and apply extension knowledge more than those with none or few years of elementary schooling.

Lockhead, et. al study (1980) further showed that the effects of education in improving farm production become more pronounced with a minimum of 4 to 6 elementary education.

Scultz (1975) argued that education was likely to be effective principally under modernizing conditions, i.e. availability of capital inputs such as fertilizers, insecticides, tractors, machinery, etc, market-oriented production and exposure to extension services. Evidence show that an additional year of schooling can increase farmers probability of adopting and applying modern farm technology by 45% (World Bank, 1991). The degree of complementarily between schooling and agricultural research and how education, and agricultural extension services interact in the encouragement of agricultural progress has also been documented (Lockhead, et. al, 1980).

The result of the study showed that about 51% of the groundnut
producers were illiterate or had informal education (Khalwa). This group of producers with low level of education 57% of them distributed in age group 41-60 and more years old. And 67% of the member of this group cultivated less than 5 feddans. The rest of the respondents had a formal education with minimum of 4 to 6 years. 66% of this group is distributed in the age group 40 years old and less, and 45% of them cultivated more than 5 feddan tables (4.4, 4.5, and 4.6).

In other words, the old producers represent the group with none or low level of education and cultivate smallholdings. The other group consists of more young producers with more years of education and relatively big holdings. Most of the producers gave different answers about the educational level, meaning that there was much variability.

Table: 4.4 Frequency distribution of respondents by educational level.

<table>
<thead>
<tr>
<th>Education level</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illiterate</td>
<td>38</td>
<td>31.7</td>
</tr>
<tr>
<td>Khalwa</td>
<td>23</td>
<td>19.2</td>
</tr>
<tr>
<td>Primary</td>
<td>38</td>
<td>31.7</td>
</tr>
<tr>
<td>Intermediate</td>
<td>4</td>
<td>3.3</td>
</tr>
<tr>
<td>Secondary</td>
<td>15</td>
<td>12.5</td>
</tr>
<tr>
<td>High education</td>
<td>2</td>
<td>1.7</td>
</tr>
<tr>
<td>Total</td>
<td>120</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Field Survey October 2003.
Table: 4.5 Frequency distribution of respondents by education levels and age group.

<table>
<thead>
<tr>
<th>Educational level</th>
<th>Age group</th>
<th>Less than 30</th>
<th>30-40</th>
<th>41-50</th>
<th>51-60</th>
<th>More than 60</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illiterate</td>
<td></td>
<td>4</td>
<td>10</td>
<td>11</td>
<td>11</td>
<td>2</td>
<td>38</td>
</tr>
<tr>
<td>Khalwa</td>
<td></td>
<td>1</td>
<td>11</td>
<td>4</td>
<td>2</td>
<td>5</td>
<td>23</td>
</tr>
<tr>
<td>Primary</td>
<td></td>
<td>9</td>
<td>13</td>
<td>10</td>
<td>5</td>
<td>1</td>
<td>38</td>
</tr>
<tr>
<td>Intermediate</td>
<td></td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Secondary</td>
<td></td>
<td>4</td>
<td>9</td>
<td>2</td>
<td></td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>High education</td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>20</td>
<td>45</td>
<td>29</td>
<td>18</td>
<td>8</td>
<td>120</td>
</tr>
</tbody>
</table>

Source: Field Survey October 2003.

Table: 4.6 Frequency distribution of the respondents by educational level and area cultivated with groundnut.

<table>
<thead>
<tr>
<th>Education level</th>
<th>Area cultivated with groundnut</th>
<th>Less than 5 feddan</th>
<th>5-10</th>
<th>More than 10</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illiterate</td>
<td></td>
<td>27</td>
<td>8</td>
<td>3</td>
<td>38</td>
</tr>
<tr>
<td>Khalwa</td>
<td></td>
<td>14</td>
<td>6</td>
<td>3</td>
<td>23</td>
</tr>
<tr>
<td>Primary</td>
<td></td>
<td>21</td>
<td>11</td>
<td>6</td>
<td>38</td>
</tr>
<tr>
<td>Intermediate</td>
<td></td>
<td>2</td>
<td></td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Secondary</td>
<td></td>
<td>8</td>
<td>2</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>High education</td>
<td></td>
<td>1</td>
<td></td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>
4.5.1 Results of correlation analysis:

The correlation test showed that there was significant correlation between age and education level, it was weak and negative ($r = -0.321$) when the age increased the educational level decreased and vice versa. This means the old producers have less educational level than the young ones.

Also there was a significant positive, weak correlation ($r = +0.236$) between the education level and the area cultivated with groundnut, (table 4.7). Groundnut producers with more school years had relatively big farms, compared to those who had less years of education.

4.5.2 The result of chi square analysis:

The result showed that the educational level and the knowledge about aflatoxin were not associated, because chi square test was not significant. The Knowledge about drought stress, harvesting on time, humidity, damaged pods and high temperature as reasons causing aflatoxin in groundnut, were not associated with the educational level. There were no differences between educated and illiterate producers, in the knowledge about aflatoxin in groundnut (table 4.8).
Table 4.7: Result of correlation analysis for the respondents (N=120) for some selected variables.

<table>
<thead>
<tr>
<th>Variables</th>
<th>X1</th>
<th>X2</th>
<th>X3</th>
<th>X4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age group X1</td>
<td>1.00</td>
<td>-0.321**</td>
<td>-0.73</td>
<td>0.141</td>
</tr>
<tr>
<td>Education level X2</td>
<td>-0.321**</td>
<td>1.00</td>
<td>-0.277**</td>
<td>0.236**</td>
</tr>
<tr>
<td>Sex X3</td>
<td>-0.073</td>
<td>-0.277**</td>
<td>1.00</td>
<td>-0.193*</td>
</tr>
<tr>
<td>Area cultivated with groundnut X4</td>
<td>0.141</td>
<td>0.236**</td>
<td>-0.193*</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Source: (Correlation analysis, 2004)

Key: * significant at 0.05 level (2-tailed).
**Significant at 0.01 level (2 tailed).

Table 4.8: Result of chi-square Analysis for the association between educational levels and perception of respondents of their knowledge about aflatoxin.

<table>
<thead>
<tr>
<th>Drought stress</th>
<th>Harvesting time</th>
<th>Damaged pods</th>
<th>humidity</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Person chi-square</td>
<td>0.803</td>
<td>0.097</td>
<td>0.589</td>
<td>0.698</td>
</tr>
<tr>
<td>Valid cases</td>
<td>99</td>
<td>99</td>
<td>99</td>
<td>99</td>
</tr>
<tr>
<td>df.</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

Source: Chi-square analysis, 2004

Significant chi-square less than 0.05.
4.5.3 Conclusion:

Additional year of education can increase producers’ ability to adopt new technologies, and enable them to improve their groundnut quality by reducing the aflatoxin contamination in their crops. Also education helps producers to accept and apply the extension knowledge more than those with no or few years of formal education. However, although in the case of the study in Kordofan it was observed that about 49% of groundnut producers had some level of education, but their knowledge about aflatoxin was not different from that of the illiterate ones. This is because extension services and information about aflatoxin were inadequate.

4.6 Gender Aspect:

Women represent 49% of the producers in the irrigated sector and 57% in the rain fed traditional sector in Sudan. Women in the rain-fed sector are primarily subsistence farmers but they also work as seasonal wage laborers in the rain-fed mechanized sector, and as hired or unpaid family laborers in the irrigated sector. Although women play a crucial role in agriculture, contributing to both the GDP and household security, their contribution to agriculture and the overall economic development process continues to be undervalued (FAO, 1994).

From the survey, it was found that 27% of groundnut producers in Kordfan were women (table 4.9).

About (84%) of the respondent women producing groundnut were in age group ranging between 30-50 years old (table 4.10). Also the majority of farm women was illiterate or had few years of education.
Agriculture is the main and only occupation for 90% of the women in the study area. The other 10% have additional occupations beside agriculture such as, laborer in schools or domestic helpers in houses in summer, and some practice income-generating activities in their houses such as hand craft, (table 4.12).

According to the study 75% of women farmers cultivate less than 5 feddans, to produce groundnut in small quantities for family consumption or for sale in small amounts, (table 4.13)

Table 4.9: Frequency distribution of respondents by Sex.

<table>
<thead>
<tr>
<th>Sex</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>88</td>
<td>73</td>
</tr>
<tr>
<td>Female</td>
<td>32</td>
<td>27</td>
</tr>
<tr>
<td>Total</td>
<td>120</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Field Survey October 2003.

Table 4.10: Frequency distribution of respondents by Sex and Age Group.

<table>
<thead>
<tr>
<th>Sex</th>
<th>Less than 30 years</th>
<th>30-40</th>
<th>41-50</th>
<th>51-60</th>
<th>More than 60</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>No.</td>
</tr>
<tr>
<td>Male</td>
<td>14</td>
<td>15.9</td>
<td>34</td>
<td>38.6</td>
<td>13</td>
<td>14.8</td>
</tr>
<tr>
<td>Female</td>
<td>6</td>
<td>18.8</td>
<td>11</td>
<td>33.3</td>
<td>5</td>
<td>15.6</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>16.7</td>
<td>45</td>
<td>37.5</td>
<td>18</td>
<td>15</td>
</tr>
</tbody>
</table>

Source: Field Survey October 2003.
Table 4.11: Frequency distribution of respondents by Sex and Educational level.

<table>
<thead>
<tr>
<th>Sex</th>
<th>Illiterate</th>
<th>Khalwa</th>
<th>Primary</th>
<th>Intermediate</th>
<th>Secondary</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>20</td>
<td>20</td>
<td>29</td>
<td>3</td>
<td>14</td>
<td>88</td>
</tr>
<tr>
<td>Female</td>
<td>18</td>
<td>3</td>
<td>9</td>
<td>1</td>
<td>1</td>
<td>32</td>
</tr>
<tr>
<td>Total</td>
<td>38</td>
<td>23</td>
<td>38</td>
<td>4</td>
<td>15</td>
<td>120</td>
</tr>
</tbody>
</table>

Source: Field Survey October 2003.

Table 4.12: The distribution of groundnut producers according to sex and Agriculture as main occupation.

<table>
<thead>
<tr>
<th>Sex</th>
<th>Yes</th>
<th>No</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>71</td>
<td>17</td>
<td>88</td>
</tr>
<tr>
<td>Female</td>
<td>29</td>
<td>3</td>
<td>32</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>20</td>
<td>120</td>
</tr>
</tbody>
</table>

Source: Field Survey October 2003.

Table 4.13: The distribution of area cultivated with groundnut by sex.

<table>
<thead>
<tr>
<th>Sex</th>
<th>Less than 5 feddans.</th>
<th>5-10 feddans.</th>
<th>More than 10 feddans.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>49</td>
<td>21</td>
<td>18</td>
</tr>
<tr>
<td>Female</td>
<td>24</td>
<td>6</td>
<td>2</td>
</tr>
</tbody>
</table>

Source: Field Survey October 2003.
97% of the women said that their crops were suffering drought stress before harvesting, because of inadequacy of rain or their delay in the season, (table 4.14).

Farmer women participate actively in various groundnut crop production operations alone or together with men. The important women activities are seed management, sowing, weeding, harvesting, drying, shelling, storage and marketing.

65.6% of women harvest their groundnut at an early or late date, (table 4.15). They use their hands or manual tools in harvesting, such techniques cause damage in 25% of their crops, (table 4.16), (4.17).

75% of women in the sample dry groundnut in small heaps by two methods, plants stacked at the ground level, closely packed into circular shape pile, pods were placed to the inside. In the other method plants stacked at the ground level closely packed over each other, pods were oriented outside (table 4.18).

After the drying process they collect the small heaps to pile in big ones. 66% of women stored their groundnut, and the rest of them sell theirs directly after harvesting, to satisfy their daily basic needs (table 4.19).

They used clay rooms (43%) and huts (57%) in their houses to store groundnut and other crops, (table 4.20). They pack groundnut in sacks (87.5%) or baskets (9.4%) (table 4.21), they use carts, animals and their heads to transport groundnut to the store- houses or to market (table 4.22).
Table 4.14: Frequency distribution of respondents by drought stress periods in groundnut and sex.

<table>
<thead>
<tr>
<th>Sex</th>
<th>Drought stress periods during the season.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Male</td>
<td>85</td>
<td>3</td>
</tr>
<tr>
<td>Female</td>
<td>31</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>116</td>
<td>4</td>
</tr>
</tbody>
</table>

Source: Field Survey October 2003.

Table 4.15: Frequency distribution of respondents by sex and harvesting on time.

<table>
<thead>
<tr>
<th>Sex</th>
<th>Harvesting on time.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Male</td>
<td>41</td>
<td>46</td>
</tr>
<tr>
<td>Female</td>
<td>11</td>
<td>21</td>
</tr>
<tr>
<td>Total</td>
<td>52</td>
<td>67</td>
</tr>
</tbody>
</table>

Source: Field Survey October 2003.

Table 4.16: Frequency distribution of respondents by sex and harvesting technique.

<table>
<thead>
<tr>
<th>Sex</th>
<th>Harvesting Technique</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Manually</td>
<td>Mechanized</td>
</tr>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>Male</td>
<td>35</td>
<td>40.2</td>
</tr>
<tr>
<td>Female</td>
<td>25</td>
<td>78.1</td>
</tr>
<tr>
<td>Total</td>
<td>60</td>
<td>50.3</td>
</tr>
</tbody>
</table>

Source: Field Survey October 2003
Table 4.17: Frequency distribution of respondents by sex and damage of pods due harvesting technique.

<table>
<thead>
<tr>
<th>Sex</th>
<th>Damaged pods due harvesting techniques.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>There is</td>
<td>There is not</td>
</tr>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>Male</td>
<td>59</td>
<td>68.6</td>
</tr>
<tr>
<td>Female</td>
<td>8</td>
<td>25</td>
</tr>
<tr>
<td>Total</td>
<td>67</td>
<td>56.8</td>
</tr>
</tbody>
</table>

Source: Field Survey October 2003.

Table 4.18: Frequency distribution of respondents by sex and drying method.

<table>
<thead>
<tr>
<th>Sex</th>
<th>Drying Methods.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Small heaps</td>
<td>Others.</td>
</tr>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>Male</td>
<td>82</td>
<td>94.3</td>
</tr>
<tr>
<td>Female</td>
<td>24</td>
<td>75</td>
</tr>
<tr>
<td>Total</td>
<td>106</td>
<td>89.0</td>
</tr>
</tbody>
</table>

Source: Field Survey October 2003.

Table 4.19: Frequency distribution of respondents by sex and storage of groundnut.

<table>
<thead>
<tr>
<th>Sex</th>
<th>Storage of groundnut.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>There is</td>
<td>There is not</td>
</tr>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>Male</td>
<td>62</td>
<td>70</td>
</tr>
<tr>
<td>Female</td>
<td>21</td>
<td>66</td>
</tr>
<tr>
<td>Total</td>
<td>83</td>
<td>69</td>
</tr>
</tbody>
</table>

Source: Field Survey October 2003.

Table 4.20: Frequency distribution of respondents by sex and type of stores.
<table>
<thead>
<tr>
<th>Sex</th>
<th>Type of stores</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Clay stores.</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>27 43.5</td>
<td>62</td>
</tr>
<tr>
<td>Female</td>
<td>9 43</td>
<td>21</td>
</tr>
<tr>
<td>Total</td>
<td>36 43</td>
<td>83</td>
</tr>
<tr>
<td></td>
<td>Bricks store.</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>3 5</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>12 57</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>15 62</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Huts.</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>28 45</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>1 3.1</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>29 48</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Metal store.</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>4 6.5</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>1 3.1</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>5 8.2</td>
<td></td>
</tr>
</tbody>
</table>

Source: Field Survey October 2003.

**Table 4.21: Frequency distribution of respondents by sex and type of packing.**

<table>
<thead>
<tr>
<th>Sex</th>
<th>Packing type</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In sack</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>87 99</td>
<td>88</td>
</tr>
<tr>
<td>Female</td>
<td>28 87.5</td>
<td>32</td>
</tr>
<tr>
<td>Total</td>
<td>115 96</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>In basket</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>1 1</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>3 9.4</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>4 3.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Unpacked</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>1 1.1</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>1 3.1</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2 0.8</td>
<td></td>
</tr>
</tbody>
</table>

Source: Field Survey October 2003.

**Table 4.22: Frequency distribution of respondents by sex and means of transportation.**

<table>
<thead>
<tr>
<th>Sex</th>
<th>Means of transportation</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vehicles</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>2 2.3</td>
<td>88</td>
</tr>
<tr>
<td>Female</td>
<td>16 50</td>
<td>32</td>
</tr>
<tr>
<td>Total</td>
<td>18 1.7</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>Carts</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>69 78.4</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>13 40.6</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>82 70.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Animals</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>16 18.2</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>2 6.3</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>18 15.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>On head</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>1 1.1</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>1 3.1</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2 2.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>1 0.8</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>1 0.8</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2 1.7</td>
<td></td>
</tr>
</tbody>
</table>

Source: Field Survey October 2003.

The survey revealed that, 69% of women had knowledge about aflatoxin in groundnut. All of them mentioned the humidity as a cause
of aflatoxin in groundnut. They had no information about the other reasons such as high temperature, drought stress, damaged pods and late harvesting (table 4.23).

77% of them acquired their knowledge about aflatoxin in groundnut from long experience and work closely with the groundnut, table (4.24). None of them acquired their knowledge from extension training courses (table 4.25).

**Table 4.23: Frequency distribution of respondents by sex and Knowledge about aflatoxin.**

<table>
<thead>
<tr>
<th>Sex</th>
<th>Knowledge about aflatoxin.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Know</td>
<td>Don’t know</td>
</tr>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>Male</td>
<td>77</td>
<td>87.5</td>
</tr>
<tr>
<td>Female</td>
<td>22</td>
<td>68.7</td>
</tr>
<tr>
<td>Total</td>
<td>99</td>
<td>82.5</td>
</tr>
</tbody>
</table>

Source: Field Survey October 2003.

**Table 4.24: Frequency distribution of respondents by sex and information of humidity as reason caused aflatoxin in groundnut.**

<table>
<thead>
<tr>
<th>Sex</th>
<th>Information about humidity.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Know</td>
<td>Don’t know</td>
</tr>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>Male</td>
<td>75</td>
<td>87.4</td>
</tr>
<tr>
<td>Female</td>
<td>22</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td>97</td>
<td>82.5</td>
</tr>
</tbody>
</table>

Source: Field Survey October 2003.

**Table 4.25: Frequency distribution of respondents by sex and source of information about aflatoxin.**

<table>
<thead>
<tr>
<th>Sex</th>
<th>Source of information.</th>
<th>Total</th>
</tr>
</thead>
</table>
### Extensioist Radio and T.V Farmers Extension posters. Experience

<table>
<thead>
<tr>
<th></th>
<th>Extensioist</th>
<th>Radio and T.V</th>
<th>Farmers</th>
<th>Extension posters.</th>
<th>Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>Male</td>
<td>5</td>
<td>6.5</td>
<td>3</td>
<td>3.9</td>
<td>23 1</td>
</tr>
<tr>
<td>Female</td>
<td>1</td>
<td>4.5</td>
<td>3</td>
<td>13.7</td>
<td>1 4.5</td>
</tr>
<tr>
<td>Total</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>26 26.3</td>
</tr>
</tbody>
</table>

Source: Field Survey October 2003.

### 4.6.1 Conclusion:

Most of farmer women surveyed in Kordfan State are found to be poor, illiterate, cultivate small holder, and none of them have any agriculture extension services. Since a number of small holder groundnut farmers in Kordfan are women, it has an important bearing on the gender issues. Gender-related issue impact labor allocation, labor requirement for groundnut production and distribution of benefits. Women work more closely with the groundnut pods and kernel. This association of women with the groundnut crop can be utilized by government to advantage in the identification and reduction of aflatoxin contamination, as they are mostly involved with seed management, storage and consumption of groundnuts.

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**CHAPTER FIVE**

RESULT AND DISCUSSION

PRE AND POST- HARVEST PRACTICES OF GROUNDNUT PRODUCERS IN KORDOFAN.
5.1 Introduction:
Aflatoxin contamination of groundnut in the producing areas including Kordofan states, can occur during its cultivation in the field, as well as during harvesting, post harvesting, storage and processing. Contamination in the field, is the result of adverse environmental conditions, such as inappropriate temperature, drought, relative humidity and insect infestation during specific growing stages of the crop.

5.2 Cultivated Varieties and Resistance:
The majority of groundnut producers in Kordofan (75.8%) cultivate the variety Barbiton, the widely grown variety which has been under cultivation since the early 1960’s. Only 24.2% of groundnut producers cultivate Sodri, the replacement variety, which is becoming very popular among producers (table 5.1). One of the possible means of reducing aflatoxin contamination of groundnut is the use of cultivators resistant to seed invasion by aflatoxin producing fungi. Resistance of groundnut seed to invasion by A. flavus has not been reported, but, in the Sudan breeding efforts for resistance to pod infection have not received any attention.

5.3 Drought stress:
Drought stress has been the factor most frequently associated with aflatoxin occurrence in groundnut before digging. Drought stress probably increases susceptibility to fungal invasion, since it decreases the moisture content of the pod and seed and greatly lowers the physiological activity of the groundnut.

The majority of groundnut producers (96.7%) whether in North or South Kordofan suffer from drought before they harvest their groundnuts (table 5.2). Despite the fact that South Kordofan is characterize by Rain-fall with annual average of 700 mm, the farmers suffer from drought stress because they planted their groundnut in late date.

5.4 Harvesting and Time:
Determining when to harvest the groundnut crop to obtain the maximum yield of top quality is one of the most critical decisions in groundnut production. On the other hand, harvesting time is one of the factors associated with field contamination of the groundnut crop by the aflatoxin producing fungus A. flavus. The result of the study indicates that 56.3% of groundnut producers in Kordofan states harvest their crops in early or late date time (table 5.3).

5.5 Harvesting Techniques:
Harvesting methods techniques, which are used to harvest
groundnut, manually or mechanically, may cause the damage to pods
and kernels. 98.3% of groundnut producers in Kordofan states harvest their
groundnuts manually or by hand tools (table 5.4). The manual
technique is the common technique among Kordofan producers when
the soil is still moist. They use manual tools when there are difficulties
in lifting the pods from dry, caked soils. It was found in the studied
sample, that manual and hand tools techniques caused damage in
56.3% of the harvested groundnut (table 5.5).

**Table No.5.1 Frequency distribution of respondents by cultivated
variety of groundnut.**

<table>
<thead>
<tr>
<th>Variety</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barbiton</td>
<td>91</td>
<td>75.8</td>
</tr>
<tr>
<td>Sodari</td>
<td>29</td>
<td>24.2</td>
</tr>
<tr>
<td>Total</td>
<td>120</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Field survey October 2003.

**Table: 5.2 Frequency distribution of respondents by drought
stress during the season.**

<table>
<thead>
<tr>
<th>Drought stress</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>116</td>
<td>96.7</td>
</tr>
<tr>
<td>No</td>
<td>4</td>
<td>3.3</td>
</tr>
<tr>
<td>Total</td>
<td>120</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Field survey October 2003.

**Table: 5.3 Frequency distribution of respondents by harvesting on
time.**

<table>
<thead>
<tr>
<th>Harvesting in time</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>52</td>
<td>43.7</td>
</tr>
<tr>
<td>No</td>
<td>67</td>
<td>56.3</td>
</tr>
<tr>
<td>Total</td>
<td>119</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Field survey October 2003.

**Table: 5.4 Frequency distribution of respondents by harvesting
methods technique.**

<table>
<thead>
<tr>
<th>Harvesting technique</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manually</td>
<td>60</td>
<td>50.4</td>
</tr>
<tr>
<td>Hand tools</td>
<td>57</td>
<td>47.9</td>
</tr>
<tr>
<td>-----------</td>
<td>-----</td>
<td>------</td>
</tr>
<tr>
<td>Mechanized</td>
<td>2</td>
<td>1.7</td>
</tr>
<tr>
<td>Total</td>
<td>119</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Field survey October 2003.

**Table 5.5 Frequency distribution of respondents by Damage of pods due harvesting technique.**

<table>
<thead>
<tr>
<th>Damaged pods</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Damaged</td>
<td>67</td>
<td>56.3</td>
</tr>
<tr>
<td>No damaged</td>
<td>52</td>
<td>43.7</td>
</tr>
<tr>
<td>Total</td>
<td>119</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Field survey October 2003.

5.6 Drying:

The crop is left for drying in the field for 3 to 4 days. Improper drying of the crop, due to labor shortages or if the crop gets affected due to intermittent rains, fungal growth may develop before the crop is transported from the farm.

89.1% of the groundnut producers in Kordofan states dried their groundnut in small heaps by two methods.

In **method one**, plants are stacked at the ground level, closely packed into circular shaped piles. Pods are placed to the inside (center of the circle). In **method two** plants are stacked at the ground level closely packed over each other. Pods are oriented outside (in one direction). The other 10.9% dry their groundnuts in plot forms or on elevated grounds (table 5.6).

Groundnut dried under method one and two are more susceptible to aflatoxin contamination than the new suggested methods by the researcher in Elobid Agriculture Research Station.

The level of contamination varied from one year to another, and this appears to be related to the rainfall amount and distribution in Kordofan states.

In the normal years aflatoxin contamination is not a serious problem, however, certain practices such as improper drying methods create condition that favour rapid development of A. flavus and consequent aflatoxin contamination.

**Table 5.6 Frequency distribution of respondents by drying Method.**

<table>
<thead>
<tr>
<th>Drying Method</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small heaps</td>
<td>106</td>
<td>89.1</td>
</tr>
<tr>
<td>Others</td>
<td>13</td>
<td>10.9</td>
</tr>
<tr>
<td>Total</td>
<td>119</td>
<td>100</td>
</tr>
</tbody>
</table>
5.7 Marketing Practices:

5.7.1 Standardization and grading:

Standardization of agricultural products involves the establishment of uniform standards of groundnut and measures and quality standards. Quality standards of groundnut are criteria that describe attributes, which give the groundnut value in the markets. A competitive agricultural marketing system and systematic development of agricultural markets, require standardized grades and measurements.

There is lack of sorting, grading and packing services in Kordofan crops markets whether in Elobid crop market or in the small villages markets. There is not any sorting or grading among groundnut producers in Kordofan states, and the response of all producers is similar. The producers using the air to clean their crops of empty pods and foreign materials and “Eltadria” is the process known among producers.

5.7.2 Packing:

After cleaning groundnuts pods are packed in jute sacks (95.8%), in baskets (3.3%) and only (0.8%) of the farmers keep their crops unpacked (table 5.7).

Seeds are seldom shelled and packed because in the kernel (seed) form they lose viability quickly than in-shell (pod) form. Therefore, seeds are mainly sold in the pod form kept in jute sacks. Many producers sell their groundnuts loose in the market.

5.7.3 Transportation

Products must be moved, often hundreds or thousands of miles from the farms where they are produced to the cities where they are to be consumed or to sea and airports for export.

The availability of transport network and commercial vehicles is an important element for speedy movement of groundnut. Thus, improving the transport infrastructure is an inevitable necessity for improving groundnut marketing.

The majority of groundnut producers (95%) in Kordofan states used carts and animals backs to transport their crops from the field to the markets or stores. Only 1.7% of them used vehicles, and the rest of them used their heads or bicycles to transport their groundnut (table 5.8).
89.2% of the producers said that there was not damage due to transportation from the field to the markets or stores (table 5.9).

**Table: 5.7 Frequency distribution of respondents by containers of packing.**

<table>
<thead>
<tr>
<th>Packing types</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>In jute sack</td>
<td>115</td>
<td>95.8</td>
</tr>
<tr>
<td>In basket</td>
<td>4</td>
<td>3.3</td>
</tr>
<tr>
<td>Unpacked</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>120</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Source: Field survey October 2003.

**Table: 5.8 Frequency distribution of respondents by means of Transportation.**

<table>
<thead>
<tr>
<th>Means</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicles</td>
<td>2</td>
<td>1.7</td>
</tr>
<tr>
<td>Carts</td>
<td>85</td>
<td>70.8</td>
</tr>
<tr>
<td>Animals</td>
<td>29</td>
<td>24.2</td>
</tr>
<tr>
<td>On head</td>
<td>3</td>
<td>2.5</td>
</tr>
<tr>
<td>Bicycles</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>120</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Source: Field survey October 2003.

**Table: 5.9 Frequency distribution of respondents by transpiration’s damage.**

<table>
<thead>
<tr>
<th>Damaged pods</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>There is</td>
<td>13</td>
<td>10.8</td>
</tr>
<tr>
<td>There is not</td>
<td>107</td>
<td>89.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>120</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Source: Field survey October 2003.

5.7.4 Storage:

According to the study 69.2% of the producers store their groundnuts (table 5.10). They store the groundnut in shell, in clay stores and huts (91%), bricks and metal stores (9%) (table 5.11). These stores were often plastid with mud and cow dug with little or no use of pesticides.

The storage of groundnut is safer in metal sheet type of store followed by brick stores as the second choice (Omer, 1992), where as clay and huts stores appeared to be the worst particularly, but the majority of producers use them. Producers generally have inadequate facilities and use their houses to keep sacks of groundnut.

Within 3 to 4 weeks after harvest time producers take about 70 to 80% of their produce personally to the market to fulfil cash requirements.
The marketable surplus of the small producers is so small that they do not find it economically feasible to take to wholesale markets, even though these distant markets often offer better prices.

Table 5.10: Frequency distribution of respondents by Storage of Groundnut.

<table>
<thead>
<tr>
<th>Storage</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>There is</td>
<td>83</td>
<td>69.2</td>
</tr>
<tr>
<td>There is not</td>
<td>37</td>
<td>30.8</td>
</tr>
<tr>
<td>Total</td>
<td>120</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Field survey October 2003.

Table: 5.11 Frequency distribution of respondents by Type of Stores.

<table>
<thead>
<tr>
<th>Type of Stores</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay store</td>
<td>36</td>
<td>43</td>
</tr>
<tr>
<td>Huts</td>
<td>40</td>
<td>48</td>
</tr>
<tr>
<td>Metal store</td>
<td>4</td>
<td>4.8</td>
</tr>
<tr>
<td>Bricks</td>
<td>3</td>
<td>4.2</td>
</tr>
<tr>
<td>Total</td>
<td>83</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Field survey October 2003.

5.8 Conclusion and Implementation for aflatoxin contamination:

The producers in Kordofan states use traditional cultivators without any characteristics of resistant seed invasion by A. flavus. This may lead to early aflatoxin contamination of producer’s groundnut.

The drought stress is the factor that affected groundnut and increase aflatoxin contamination. It is unpredictable and not easy to control especially in rain fed areas such as Kordofan states. The drought stress period before lifting in Kordofan producer’s groundnut may lead to aflatoxin contamination of groundnut in pre-harvest stage.

Early sowing is desirable so that the crop can mature and be harvested before the end of the rainy season when the soil is still moist. Because of the unpredictable nature of the rainy season it is not always possible to avoid rain falling on groundnuts that have been
lifted in the field, which increase the humidity and the occurrence of aflatoxin contamination.

Delayed sowing may lead to early and immature harvests that may have implications for aflatoxin contamination. Delay in harvesting may lead to over-maturity, germination of seed before harvest and or damage to crop due to intermittent rains, which could provide conditions suitable for aflatoxin contamination.

Working with manual and hand tools has a few implications for damages and consequently for possible aflatoxin contamination. According to the studies producers, harvesting with hand tools, causes physical damage and injury to the pods and kernel.

The common two methods of drying among groundnut producers in Kordofan states have many disadvantages. In method one termites may be a real problem, especially in the bottom layer of plants, also the poor ventilation and exposure to sunlight. Improper field drying among Kordofan producers or wetting due to rains may cause the development of aflatoxin contamination during the stacking period.

In the absence of any regulation relating to marketable crop standards, producers in Kordofan sell their produce as it suits them or as per whatever shape they harvest. Sorting the produce is rarely followed except in auction markets and this is not a common practice. Producers’ marketing practices and their relationship to the various marketing channels, with which they trade their groundnut, clearly indicate that. They need not account for aflatoxin contamination as prerequisite criteria for sale. A mechanism to look for aflatoxin during the pre and post-harvest management ignores and does not identify aflatoxin contamination in groundnut.

CHAPTER SIX
RESULT AND DISCUSSION
MARKET INFORMATION AND AWARENESS
6.1 Introduction:

Lack of accurate market information leads to higher risks in production and the marketing of groundnut. Small producers need to be more aware of adjusting their production to market demand and to identify the preference in national and export markets.

Farmers have lack of information about the relationship between production and marketing practices of groundnut and aflatoxin contamination. Moreover, the lack of information for traders and other market participants result in increasing the risk of aflatoxin contamination in groundnut especially in the domestic markets.

6.2 Knowledge about aflatoxin:

The result of the study showed that 82.5% of the producers in Kordofan knew the aflatoxin in groundnut as a disease, they called it locally “Elsofan Elakhadar”. Only 17.5% of the producers said that they did not know the aflatoxin contamination in groundnut (table 6.1).

The producers showed a similar response when they were asked about the knowledge about aflatoxin.

Producers who said they knew aflatoxin in groundnut 99 producers, were asked about the reasons causing aflatoxin contamination of groundnut. There were two types of question firstly, every reason in a separate question. And then about all the reasons together to know how many reasons from the five they would mention. The result was as follows:

99% of the producers did not mention the drought stress as a reason causing aflatoxin in groundnut, only 1% mentioned it (table 6.2).
5% only of the producers mentioned harvesting time as a reason causing aflatoxin in groundnut (table 6.3).

2% of the producers named damaged pods as a reason causing aflatoxin contamination in groundnut, and 98% said they didn’t know (table 6.4).

98% of the producers mentioned the high humidity, caused by the plastic sack or rain during drying process of groundnut as the cause of aflatoxin contamination. Only 2% of them said they didn’t know it (table 6.5).

5% only of the producers named the high temperature during storage as a reason of aflatoxin contamination. The rest of them 95% said they didn’t know it (table 6.6).

When asked to mention the reasons causing aflatoxin in groundnut 89% of producers mentioned one reason and only 11% mentioned 2 reasons from the known five reasons. None of them mentioned more than two reasons (table 6.7).

Table: 6.1 Frequency distribution of respondents by their knowledge about aflatoxin in groundnut.

<table>
<thead>
<tr>
<th>Response</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Know</td>
<td>99</td>
<td>82.5</td>
</tr>
<tr>
<td>Don’t know</td>
<td>21</td>
<td>17.5</td>
</tr>
<tr>
<td>Response</td>
<td>Frequency</td>
<td>Percent</td>
</tr>
<tr>
<td>----------</td>
<td>-----------</td>
<td>---------</td>
</tr>
<tr>
<td>Know</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Don’t know</td>
<td>98</td>
<td>99</td>
</tr>
<tr>
<td>Total</td>
<td>99</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Field survey October 2003.

**Table: 6.2 Frequency distribution of respondents by their knowledge about drought stress as reason causing aflatoxin in groundnut.**

<table>
<thead>
<tr>
<th>Response</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Know</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Don’t know</td>
<td>94</td>
<td>95</td>
</tr>
<tr>
<td>Total</td>
<td>99</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Field survey October 2003.

**Table: 6.3 Frequency distribution of respondents by their knowledge about harvesting time as a reason causing aflatoxin in groundnut.**

<table>
<thead>
<tr>
<th>Response</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Know</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Don’t know</td>
<td>97</td>
<td>98</td>
</tr>
</tbody>
</table>

Source: Field survey October 2003.

**Table: 6.4 Frequency distribution of respondents by their knowledge about damaged pods as a reason causing aflatoxin in groundnut.**
Total | 99 | 100
---|---|---
Source: Field survey October 2003.

**Table: 6.5 Frequency distribution of respondents by their knowledge about humidity as a reason causing aflatoxin in groundnut.**

<table>
<thead>
<tr>
<th>Response</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Know</td>
<td>97</td>
<td>98</td>
</tr>
<tr>
<td>Don’t know</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>99</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Field survey October 2003.

**Table: 6.6 Frequency distribution of respondents by their knowledge about High temperature as a reason causing aflatoxin in groundnut.**

<table>
<thead>
<tr>
<th>Response</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Know</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Don’t know</td>
<td>94</td>
<td>95</td>
</tr>
<tr>
<td>Total</td>
<td>99</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Field survey October 2003.

**Table: 6.7 Frequency distribution of respondents by their knowledge about reasons causing aflatoxin contamination in groundnut.**

<table>
<thead>
<tr>
<th>The Reason</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time of harvesting</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>humidity</td>
<td>87</td>
<td>87.9</td>
</tr>
<tr>
<td>Time of harvesting and humidity</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Damaged pods and humidity</td>
<td>2</td>
<td>2.1</td>
</tr>
<tr>
<td>High temperature and humidity</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>High temperature and drought stress</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>99</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Field survey October 2003.

6.2.1 Socio-economic characteristics and information about aflatoxin in groundnut:
Chi-square analysis:

From the chi-square analysis there is no relationship between the socio-economic characteristics such as age, educational level, agriculture as the main occupation, area cultivated with groundnut and the knowledge about aflatoxin in groundnut.

There is a significant association between sex and knowledge about aflatoxin in groundnut (table 6.8).

Men are more aware about aflatoxin contamination in groundnut because they are the majority and practice agriculture as the main occupation for their family income. While women process groundnut for family consumption or as a way of supplementing family income, together with other activities such as childcare.

Chi square analysis showed that there were no significant association between the information about reason causing aflatoxin contamination in groundnut and socio-economic characteristic of the farmers such as age, education level and sex. The only socio-economic characteristic that had a significant association with information about reasons causing aflatoxin among farmers was (agriculture as the main occupation) (table 6.9). Farmers who practiced agriculture as a main occupation had information about their crops more than those who practice the agriculture as a secondary occupation. The farmers acquired the information about aflatoxin in groundnut and factors, which caused it, from their experience and their work closely in groundnuts production.

Table 6.8 Result of chi-square Analysis for the association between knowledge about aflatoxin contamination in groundnut and socio-economic characteristics of respondents.
Table 6.9 Result of chi-square Analysis for the association between socio economic characteristics of respondents and information about reasons causing aflatoxin contamination.

<table>
<thead>
<tr>
<th>Age</th>
<th>Sex</th>
<th>Educational level</th>
<th>Agriculture as the main occupation</th>
<th>Area cultivated with groundnut</th>
</tr>
</thead>
<tbody>
<tr>
<td>Person chi-square 2sided</td>
<td>0.849</td>
<td>0.017</td>
<td>0.097</td>
<td>0.334</td>
</tr>
<tr>
<td>Valid cases</td>
<td>120</td>
<td>120</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>D.f</td>
<td>4</td>
<td>1</td>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>

Significant chi-square less than 0.05.

Source: Chi-square analysis, 2004

6.2.2 Pre-harvest and Post-harvest practices and information about aflatoxin in groundnut:

Chi-square analysis:
The chi square analysis showed that there was no association between pre-and post-harvest practices of the producers in Kordofan and their information about reasons causing aflatoxin in groundnut. The test showed that there was no significant association between time of harvesting and information about harvesting time as a reason of aflatoxin in groundnut (table 6.10). Because the producers hadn’t any information about the effect of time of harvesting on their groundnut quality, they didn’t care about the time of harvesting.

Also there is no association between harvesting technique and the information about damaged pods as reason of aflatoxin contamination (table 6.11). Packing and storage as post-harvest practices haven’t any association with the information about humidity as a reason causing aflatoxin contamination in groundnut. The only post harvest practice, which is associated with information about humidity as a reason causing aflatoxin contamination, is drying methods (table 6.12).

The majority of groundnut producers mentioned humidity as a reason of aflatoxin contamination in groundnut, and some of them mentioned it as the only reason of aflatoxin in their crops. Because of the farmers awareness about the effect of the humidity on their crops they try to choose good methods of drying. They use methods of drying to enable them to ensure good exposure to sunlight and good ventilation.

In spite of the fact that the majority of the producers in Kordofan mentioned the humidity as one of aflatoxin causes in groundnut, they didn’t avoid the humidity in their post-harvest practices rather than
drying, which increase the incidence of aflatoxin contamination in their groundnuts.

Table 6.10: Result of chi-square Analysis for the association between harvesting time as a practice and harvesting in time as a reason causing aflatoxin contamination.

<table>
<thead>
<tr>
<th></th>
<th>Sig. 2sided</th>
<th>D.f</th>
<th>Valid cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Person chi-square</td>
<td>0.932</td>
<td>1</td>
<td>98</td>
</tr>
</tbody>
</table>

Significant chi-square less than 0.05.
Source: Chi-square analysis, 2004

Table 6.11: Result of chi-square Analysis for the association between harvesting technique and damaged pods as a reason causing aflatoxin contamination.

<table>
<thead>
<tr>
<th></th>
<th>Sig. 2sided</th>
<th>D.f</th>
<th>Valid cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Person chi-square</td>
<td>0.375</td>
<td>2</td>
<td>98</td>
</tr>
</tbody>
</table>

Significant chi-square less than 0.05.
Source: Chi-square analysis, 2004
Table 6.12: Result of chi-square Analysis for the association between drying, packing and storage as post-harvest practices and information about humidity as a reason causing aflatoxin contamination.

<table>
<thead>
<tr>
<th>Drying method</th>
<th>Packing</th>
<th>Type of stores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Person chi square 2sided</td>
<td>0.014</td>
<td>0.817</td>
</tr>
<tr>
<td>Valid cases</td>
<td>98</td>
<td>99</td>
</tr>
<tr>
<td>D.f</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

Significant chi-square less than 0.05.

Source: Chi-square analysis, 2004

6.3 Information about Risk to human and animal health from aflatoxins:

The result in this study showed that 55.5% of the producers in Kordofan knew the information that contaminated groundnut is risky for human and animals. 44.5% didn’t know the risk of aflatoxin (table 6.13). However, those who said that they knew the risk of aflatoxin, failed to mention any of the occupational hazards in man, because they didn’t associate those symptoms to dealing with contaminated groundnut. Most of them said that contaminated groundnut caused stomach pain in human beings and might cause death in animals such as goats.

6.4 Access to market information:

Insufficient market knowledge about the effect of aflatoxin on groundnut marketing prevents the producers from obtaining fair and good prices for their groundnuts. When asked about the effect of aflatoxin on groundnut marketing and prices only 24.2% of the producers said that
there was an effect 75.8% had not information about the effect of aflaatoxin on the price and marketing of groundnut (table 6.14). The main problem of marketing is the lack of training for market participants; (farmers and traders) on improving the quality of groundnut and marketing activities.

**Table: 6.13 Frequency distribution of respondents by their Knowledge about aflatoxin risk on health.**

<table>
<thead>
<tr>
<th>Response</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Know</td>
<td>55</td>
<td>55.5</td>
</tr>
<tr>
<td>Don’t know</td>
<td>44</td>
<td>45.5</td>
</tr>
<tr>
<td>Total</td>
<td>99</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Field survey October 2003.

**Table: 6.14 Frequency distribution of respondents by their Knowledge about the effect of aflatxin on prices and marketing of groundnut.**

<table>
<thead>
<tr>
<th>The effect</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>There is</td>
<td>24</td>
<td>24.2</td>
</tr>
<tr>
<td>There is not</td>
<td>75</td>
<td>75.8</td>
</tr>
<tr>
<td>Total</td>
<td>99</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Field survey October 2003.

6.5 Knowledge Access and Extension work:

The only available literature indicates the extension training work about the aflatoxin in groundnut and its effect on quality and how to reduce it by farmers’ practices, is the AOAD program in 1995.
This program was designed to increase the productivity and production of oil seed in Sudan.

One of the objectives of this program is to strengthen research and extension services in regard to production of oil seed crops through training provision of equipment and on farm demonstration. Also to strengthen programs for quality improvement and control.

Training of farmers was carried out as planned, it comprised farm visits, meetings, field days and distribution of posters particularly with regard to best methods of harvesting and drying groundnuts avoid infection with A. flavus which produces the toxin aflatoxin.

The farmer’s response to governmental support in extension was very highly positive. They expressed their appreciation of the efforts of extension officials and the team has also the same impression about extension activities in the area. The control of aflatoxin and use of jute sacs instead of plastic ones was one of post-harvest practices that were introduced for groundnut.

From the survey, it is clear that the information on groundnut production and marketing techniques was available to the producers in the study area through either the State Ministry of Agricultural or organizations such as FAO in North Kordofan and Rural Development committee in South Kordofan.

The majority of the groundnut producers 88% in Kordofan acquired their knowledge about aflatoxin in groundnut from their long experience or from the experience of the old producers. Only 11% of the producers took their information from extension training courses and extension materials (table 6.15). Those extension-training courses were about the effect of aflatoxin on groundnut marketing and the risk to human and animal’s health from aflatoxin.
6.4.1 Source of information and soci-economic characteristics of groundnut producers:

Chi-square analysis:

Chi-square analysis showed that there is no association between age, education level, sex and area cultivated with groundnut and source of information about aflatoxin contamination in groundnut.

The test showed that there is significant association between agriculture as a main occupation and source of information. Producers who practice agriculture as main occupation acquire their knowledge about aflatoxin contamination in groundnut from their experiences or from experience of the old producers (table 6.16).

Table: 6.15 Frequency distribution of respondents by the source of information.

<table>
<thead>
<tr>
<th>The source</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extension officer</td>
<td>5</td>
<td>5.1</td>
</tr>
<tr>
<td>Radio &amp; T.V</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Extension posters</td>
<td>26</td>
<td>26.3</td>
</tr>
<tr>
<td>Experience</td>
<td>62</td>
<td>62.6</td>
</tr>
<tr>
<td>Other farmers</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>99</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Field October survey 2003.
Table 6.16: Result of chi-square Analysis for the association between source of information about aflatoxin contamination in groundnut and socio-economic characteristics of respondents.

<table>
<thead>
<tr>
<th></th>
<th>Age</th>
<th>Sex</th>
<th>Educational level</th>
<th>Agriculture as the main occupation</th>
<th>Area cultivated with groundnut</th>
</tr>
</thead>
<tbody>
<tr>
<td>Person chi-square 2sided</td>
<td>0.53</td>
<td>0.161</td>
<td>0.204</td>
<td>0.000</td>
<td>0.342</td>
</tr>
<tr>
<td>Valid cases</td>
<td>99</td>
<td>99</td>
<td>99</td>
<td>99</td>
<td>99</td>
</tr>
<tr>
<td>D.f</td>
<td>20</td>
<td>5</td>
<td>25</td>
<td>5</td>
<td>10</td>
</tr>
</tbody>
</table>

Significant chi-square less than 0.05.

Source: Chi-square analysis, 2004

6.5 Conclusion:

Poor extension system is a major constraint facing the development of groundnut quality.

The limited number of extension officers and the technical staff are not well trained to provide the necessary support in the production, processing and marketing of groundnut instead of improving the quality.

The groundnut research in Sudan has been addressing very limited problems of the groundnut quantity rather than quality.

There is not any literature about research on groundnut variety, which resist the aflatoxin contamination in Sudan.

Information on issues such as aflatoxin contamination is simply not available to the producers.

The complexity in the identification of aflatoxins and the lack of clear perspective about its control measures among the information provided,
leads to this deficiency of information on aflatoxins among the producers.

CHAPTER SEVEN
SUMMARY, CONCLUSION AND RECOMMENDATIONS

7.1 Summary:

Aflatoxin is a naturally occurring mycotoxin produced by two species of fungi. Aflatoxins have been found not only in groundnuts, but also in cotton seed, corn, soybean meal, fish meal, and other grains, seed and feeds.

Aflatoxin contamination of groundnut can occur during its cultivation in the field, as well as during harvesting, post harvesting, storage and processing.

The objectives of this study are to assess the socio-economics characteristics of groundnut producers. Also to assess the awareness of farmers about recommended pre-harvest and post-harvest practices of groundnut production which reduce the aflatoxin contamination in groundnut and the role of extension program in transferring the information about aflatoxin to the groundnut producer. The study also aims to design a set of marketing extension recommendations to ease the job of the extension officer.

To achieve the goals of the study, North and South Kordofan were selected to represent the area of the study in the rain-fed area because the aflatoxin contamination in groundnut is associated with drought stress, which is common in the rain-fed area than in the irrigated area.

The study depended on primary data collected through questionnaires, secondary data including reviewing the literature and other available data set from various sources. The survey was conducted during the period September to October 2003. Frequency distribution, correlation coefficient and chi-squares were used to test the hypotheses of the study.

Groundnut producers were interviewed about their ages and finding is 78.3% of them are 50 years old and less. The other group about
21.7% is more than 50 years old.

Groundnut growers were asked about the areas of land cultivated. The result is 60.8% of the producer in Kordofan cultivate less than 5 feddan. 22.5% of the producer cultivate 5-10 feddans and only 16.7% cultivate more than 10 feddans.

The agriculture is the main occupation for 83.3% of groundnut farmers in Kordofan. Only 16.7% of them have another activities beside groundnut cultivation. The other activities those producer practices are such as hired laborer, employee, merchant and other income generating activities by women.

The result of the study showed that 51% of the groundnut producers were illiterate or had informal education (Khalwa). This group of producers with low level of education 57% of them was distributed in age group 41-60 and more years of age. And 67% of the members of this group cultivated less than 5 feddans each.

The rest of the respondents had a formal education with minimum of 4 to 6 years. 66% of this group distributed in the age group 40 years old and less, and 45% of them cultivated more than 5 feddan each.

The correlation test showed that there was significant correlation between age and education level; it was weak and negative (r= – 0.321) when the age increased the education level decreased and vice versa. Also there was a significant positive, weak correlation (r=+ 0.236) between the education level and the area cultivated with groundnut.

The result showed that the education level and the knowledge about aflatoxin were not associated, because chi square test was not significant. The Knowledge about drought stress, harvesting on time, humidity, damaged pods and high temperature as reasons causing aflatoxin in groundnut, were not associated with the educational level.

From the survey, it was found that 27% of groundnut producers in Kordfan were women About (84%) of the respondent women producing groundnut were in the age group ranging between 30-50 years old. Also the majority of farm women were illiterate or had few
years of education.

Agriculture is the main and only occupation for 90% of the women in the study area. The other 10% have additional occupations beside agriculture such as, laborers in schools or domestic helpers in houses in the off season in summer, and some practice income-generating activities in their houses such as handcraft. According to the study 75% of women farmer cultivate less than 5 feddans, to produce groundnut in small quantities for family consumption or for sale in small amounts.

The majority of groundnut producers in Kordofan (75.8%) cultivate the variety Barbiton, the widely grown variety which has been under cultivation since the early 1960’s. Only 24.2% of groundnut producers cultivate Sodri, the replacement variety, which is becoming very popular among producers. The majority of groundnut producers (96.7%) whether in North or South Kordofan suffer from drought before they harvest their groundnut.

98.3% of groundnut producers in Kordofan harvest their groundnuts manually or by hand tools. The manual technique is the common technique among Kordofan producers when the soil is still moist. They use manual tools when there are difficulties in lifting the pods from dry, caked soils. It was found in the studied sample, that manual lifting and hand tool techniques caused damage in 56.3% of the harvested groundnut.

89.1% of the groundnut producers in Kordofan dried their groundnuts in small heaps by two methods. In **method one**, plants are stacked at the ground level, closely packed into circular-shaped piles. Pods are placed to the inside (center of the circle). In **method two** plants are stacked at the ground level closely packed over each other. Pods are oriented outside (in one direction). The other 10.9% dry their groundnuts in plot forms or on elevated grounds.

There is not any sorting or grading among groundnut producers in Kordofan. The response of all producers is similar. The producers
using the air to clean their crops of empty pods and foreign materials by winnowing or “El tadria” as the process is known among producers. After cleaning groundnuts pods are packed in jute sacks (95.8%), in baskets (3.3%) and only (0.8%) of the farmers keep their crops unpacked.

The majority of groundnut producers (95%) in Kordofan used carts and animals backs to transport their crops from the field to the markets or stores. Only 1.7% of them used vehicles, and the rest of the used their heads or bicycles to transport their groundnut. 89.2% of the producers said that there was no damage due to transportation from the field to the markets or stores.

According to the study 69.2% of the producers store their groundnuts. They store the groundnut in shell, in clay stores and huts (91%), bricks and metal stores (9%). These stores were often plastered with mud and cow dug with little or no use of pesticides.

The result of the study showed that 82.5% of the producers in Kordofan knew the aflatoxin in groundnut as a disease, they called it locally “Elsofan Elakhadar”. Only 17.5% of the producers said that they did not know the aflatoxin contamination in groundnut. 99% of the producers didn’t mention the drought stress as a reason causing aflatoxin in groundnut, only 1% mentioned it. 5% only of the producers mentioned harvesting time as a reason causing aflatoxin in groundnut.

2% of the producers named damaged pods as a reason causing aflatoxin contamination in groundnut, 98% said they didn’t know.

98% of the producers mentioned the high humidity, which was caused by plastic sacks or rains during the drying process of groundnut as the cause of aflatoxin contamination. Only 2% of them said they didn’t know it. 5% only of the producers named the high temperature during storage as a reason of aflatoxin. The rest of them 95% said they didn’t know it.

When asked to mention the reasons causing aflatoxin in groundnut 88% of producers mentioned one reason and only 12% mentioned
2 reasons from the known five reasons. None of them mentioned more than two reasons.

From the chi-square analysis, there is no relationship between the soci-economic characteristics such as age, education level, agriculture as the main occupation and area cultivated with groundnut and the knowledge about aflatoxin in groundnut.

There is a significant association between sex and knowledge about aflatoxin in groundnut.

Chi square analysis also showed that there was no significant association between the information about reason causing aflatoxin contamination in groundnut and socio-economic characteristic of the farmers such as age, education level and sex.

The only socio-economic characteristic that had a significant association with information about reasons causing aflatoxin among farmers was (agriculture as the main occupation).

The chi square analysis showed that there was no association between pre-and post-harvest practices of the producers in Kordofan and their information about the reasons causing aflatoxin in groundnut.

The test showed that there was no significant association between time of harvesting and information about harvesting time as a reason of aflatoxin in groundnut.

Also there is no association between harvesting technique and the information about damaged pods as reason of aflatoxin contamination. Packing and storage as post-harvest practices haven’t any association with the information about humidity as a reason causing aflatoxin contamination in groundnut. The only post harvest practice, which is associated with information about humidity as a factor causing aflatoxin in groundnut, is the drying method.
The result in this study showed that 55.5% of the producers in Kordofan knew the information that contaminated groundnut was risky for human and animals. 44.5% didn’t know the risk of aflatoxin. When asked about the effect of aflatoxin on groundnut marketing and prices only 24.2% of the producers said that there was an effect. 75.8% had not information about the effect of aflatoxin on the price and marketing of groundnut.

The majority of the groundnut producers 89% in Kordofan acquired their knowledge about aflatoxin in groundnut from their long experience or from the experience of the old producers. Only 11% of the producers took their information from extension training courses and extension materials.

Chi-square analysis showed that there is no association between age, education level, sex and area cultivated with groundnut and source of information about aflatoxin contamination in groundnut.

The test showed that there is significant association between agriculture as a main occupation and source of information.

7.2 Conclusions:

A lot of groundnut producers have some level of education, but their knowledge about aflatoxin is however not different from that of the illiterate ones. This is because extension services and information about aflatoxin are inadequate.

Women in Kordofan participate actively in various groundnut production operations alone or together with men. The important women activities are seed management, sowing, weeding, harvesting, drying, shelling, storage and marketing. Women work more closely with the groundnut pods and kernel. This association of women with
the groundnut crop can be utilized to advantage in the identification and reduction of aflatoxin contamination.

The farmers in Kordofan use traditional cultivators without any characteristics of resistant seed invasion by A. flavus. This may lead to early aflatoxin contamination of farmers’ groundnut.

The drought stress period before lifting in Kordofan farmer’s groundnut may lead to aflatoxin contamination of groundnut in pre-harvest stage.

Early sowing is desirable so that the crop can mature and be harvested before the end of the rainy season whilst the soil is still moist. Delayed sowing may lead to early and immature harvests that may have implications for aflatoxin contamination.

Delay in harvesting may lead to over maturity, germination of seed before harvest and or damage to crop due to intermittent rains, which could provide conditions suitable for aflatoxin contamination. Working with manual and hand tools has a few implications for damages and consequently for possible aflatoxin contamination.

Improper field drying among Kordofan producers or wetting due to rains may cause the development of aflatoxin contamination during the stacking period.

In the absence of any regulation relating to marketable crop standards, producers in Kordofan sell their produce as it suits them or as per whatever produce they harvest. Sorting the produce is rarely followed and only in auction markets this is not a common practice. A mechanism to look for aflatoxin during the pre and post-harvest management ignores and does not identify aflatoxin contamination in groundnut.

Men are more aware about aflatoxin contamination in groundnut because they are a majority and practice agriculture as the main occupation for their family income. Women
process groundnut for family consumption or as a way of supplementing family income, beside other activities such as childcare.

Producers who practice agriculture as a main occupation had information about their crops more than those who practice the agriculture as a secondary occupation. Also they acquire their knowledge about aflatoxin contamination in groundnut from their experiences or from experience of the old producers.

The producers acquire the information about aflatoxin in groundnut and factors, which caused it, from their experience and their work closely in groundnuts production.

The main problem of marketing is the lack of training for market participants; (farmers and traders) on improving the quality of groundnut and marketing activities.

Poor extension system is a major constraint facing the development of groundnut quality. The limited number of extension officers and the technical staff are not well trained to provide the necessary support in the production, processing and marketing of groundnut instead of improving the quality.

Information on issues such as aflatoxin contamination is simply not available to the producers. The complexity in the identification of aflatoxins and the lack of clear perspective about its control measures among the information provided, leads to this deficiency of information on aflatoxins among the producers.

**7.3 Recommendations:**

**7.3.1 Extension’s Recommendations:**
1- Farmers social organizations should be promoted to work effectively, especially on tackling farmer’s problems of finance and the expensive cost of inputs and marketing of groundnut.

2- Secondary transfer of technologies from farmer to farmer communication should be improved. Groups of farmers should be motivated and trained about all the practices that can reduce aflatoxin in groundnut and then demonstrate extension recommendations to the farmers.

3- The linkage between research stations in the Sudan such as Elobied Research Station and extensions institutions should be improved in order to improve the pre- and post- harvest practices of groundnut producers which will lead to a good quality of groundnut and free of aflatoxin contamination.

4- Improvement of agricultural information system and use the mass media to expose larger numbers of farmers to information about aflatoxin in groundnut. The use of audio visual aid to transfer knowledge about aflatoxin and its association with production and marketing practices should be improved.

5- One of the key elements for improving marketing extension services, is the well-trained staff to provide the necessary support in the production, processing and marketing of groundnut instead of improving the quality.

7.3.2 Pre- and Post harvest Recommendations:

At each stage in the production and marketing of groundnut there are possibilities for quality improvement. The extension officer will have to identify the main problems and concentrate his efforts on those areas. He will need to translate the market requirements into practical recommendations for groundnut producers.
7.3.2.1 Pre-harvest Recommendations:

7.3.2.1.1 Input supply:

Both quantity and quality of groundnut produced are affected by difficulties in obtaining inputs. The correct planting material is particularly important. Often the export market has strong preference for good variety of groundnut, but in the domestic market consumers don’t care about the variety very much.

Most of the groundnut in Kordofan suffer from the lack of planting material in the time of planting of groundnut which forced the groundnut producers to cancel the groundnut from their cultivation plans. One of their critical constraints to obtain the planting material is often shortage of funds.

The extension officer can help with the supply of production credit by providing the bank with cost of production data and expected return. Also his role is to advise the seed suppliers on which varieties they should supply and the producers on which varieties to plant. The extension officer should be alert to opportunities where producers themselves can become input suppliers.

7.3.2.1.2 Groundnut Planting:

The appropriate time of groundnut planting is after the rain reaches more than 10mm, which is usually near 15 July. Early sowing leads to early harvesting, the crop can mature and be harvested before the end of the rainy season whilst the soil is still moist. These conditions increase the relative humidity of the groundnut during the drying which increase the incidence of aflatoxin contamination. Delay in planting of groundnut may increase the risk of drought stress, because the crop can mature after the end of the rainy season be exposed to drought stress before harvest.
Drought stress has strong effect on the competitive compounds, which influence the growth of *A. flavous* in groundnut. It also prevents proper maturation of the groundnut seeds.

Studies proved that groundnut harvested from land planted with groundnut in the previous year, were more highly infested with fungi and contaminated with aflatoxin more than groundnut grown on land planted with other crops in the previous year (Pettit and Taber, 1968).

The extension officer should be able to advise producers on planing their crop. He can advise producer to plant groundnut in the recommended time to optimize the use of soil moisture for growth and avoid drought late in the growing season. Also another important criteria such as labor availability and crop rotation, will have to be taken into consideration by producers to minimize the aflatoxin contamination of their groundnut.

### 7.3.2.2 Post-Harvest Recommendations:

The main emphasis here is on commercial implications of different harvest and post-harvest practices. Because improper conditions during post-harvest such as high moisture, temperature, or mechanical damage can influence invasion of fungus that produces the aflatoxin.

The timing, technique and conditions at harvesting affect the groundnut quality. What does groundnut producer often not understand is the effect of their produce in the market.

#### 7.3.2.2.1 Time of Harvest:

Harvesting in time could reduce crop moisture to a point where the formation of mould would not occur.

The extension officer can advice producers to plant their groundnut in time and harvest the crop after 3 months. He can help them to provide the labour by formation of action group to work together to harvest their groundnut in time to avoid over maturity.
7.3.2.2.2 Harvesting Technique:

Care should be taken to avoid mechanical damage to the groundnut during harvest. Damaged pods are highly vulnerable to aflatoxin contamination. The minimum damage of shells during mechanized harvesting of the crop reduces the mould contamination.

The extension officer can teach producers the harvesting methods that can minimize the mechanical damages in their crops. In sandy soils pulling by hands can be a proper method to harvest groundnut especially when the soil is still moist. Also the careful use of hand tools such as (Elторia and Elnagama) in dry sandy soils or in mixed soils can be safe and cause a minimum damage.

7.3.2.2.3 Drying:

Proper drying method and drying rate may influence the degree of fungal invasion and aflatoxin contamination.

The indigenous methods, which are used by groundnut producer in Kordofan, have many disadvantages that exposed the crop to aflatoxin contamination during drying. Extension officers can suggest new recommended drying methods to minimize the chance for aflatoxin contamination incidence. Those recommended methods such as “Newly Suggested Method” and “Inverted Windrows Method”, which are suggested by the researcher in Elobied Agriculture Research Station can be useful.

In the “Newly Suggested Method” plants are gathered in piles, in which the plants are turned upside-down and the pods are on top. This method ensures good exposure to sunlight and good ventilation. Also pods are relatively better protected from rats.
In the “Inverted Windrow Method” plants are placed in long rows, with pods exposed to full sunlight, which enables the plants to receive full sunlight and good ventilation.

Extension officers can explain each method to the producers and indicate its advantages and encourage them to use the new methods. He can also explain to the producers that by following these proper methods of drying, fungal infection can be avoided.

**7.3.2.2.4 Sorting and grading:**

In Kordofan there is no sorting and grading done by the traditional groundnut producers before marketing or in the weekly village markets. Standards may however, be enforced if the crops are to be exported to international market. Groundnut for long term storage should be well-dried and free of shriveled and damaged pods by sorting. Groundnut is generally separated according to quality criteria. It may also be graded according to color and pod size. The crop then is normally packed into jute sacks. This facilitates marketing into different markets.

Electronic sorting and hand picking of damaged, immature or mould-infested pods, can significantly reduce the contamination of groundnut in shell. The extension officer can introduce sorting machines to producers’ in-groups and train them on how to operate them. Also he can assist by providing funds to producers’ cooperatives to buy sorting machine for every group of farmers and then they can share the repayment. The individual producers of groundnut in Kordofan don’t have the ability to pay for a sorting machine. He can demonstrate the differences between electronically sorted crop and the crops of traditional producers.
7.3.2.2.5 Packing:

The main functions of packing are to reduce damage and ensure good ventilation of pods and to sort the groundnut into acceptable size for the market and handling. Good packing can also enhance the attractiveness of the produce. Care in harvesting and handling will help to eliminate scars and damage in pods. The majority of groundnut producers in Kordofan use jute sacks to pack their groundnut. There are a number of advantages for using jute sacks, including low costs and good ventilation of the pods.

The extension officer should try to develop and improve the use of existing packing methods. This may be achieved through improvements in the handling system. He also can advise producers to avoid the plastic sack, which increase the humidity and temperature of the groundnut pods, which increase aflatoxin contamination.

7.3.2.2.6 Storage:

Groundnut can be stored for both short term and long term purposes. Small producers store their groundnut for a short time and sell the crop in small quantities depending on the family needs. The long-term storage is for purposes of export.

Producers of groundnut in Kordofan usually cultivate groundnut in small areas and store their produce in clay rooms or huts in their houses, to minimize the cost. Because of their limited resources and finance they cannot build a special store for groundnut or rent store outside their houses.

Dried selected produce should be stored in a well-ventilated place with low humidity and free of stored product pests. The store should be protected from the rain in the rainy season using material, which prevent water from reaching the stored crop such as metal sheets or
bricks. Also using plastic sheets to cover windows and sacks to protect the crop of high humidity.

Strict control of storage facilities and conditions including temperature, moisture, physical damage of the product through handling or pests, reduce or prevent aflatoxin contamination in groundnut.

The extension officer can improve on-farm storage practices by training producers in correct techniques and by himself carrying out comparisons between the results of recommended practices and those that farmers normally practice.

Table 7.1 Generalized Storage Advice for Groundnut

<table>
<thead>
<tr>
<th>Advice</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harvest groundnut at the proper maturity stage.</td>
<td>High percentage of A. flavus invasion occurring over-mature pods than in immature and mature seed and pods from the same plant at harvest.</td>
</tr>
<tr>
<td>Store well dried groundnut.</td>
<td>To minimize the moisture content of groundnut during storage.</td>
</tr>
<tr>
<td>Advice</td>
<td>Reason</td>
</tr>
<tr>
<td>--------</td>
<td>--------</td>
</tr>
<tr>
<td>Groundnut should be stored as pods rather than kernels.</td>
<td>To minimize compression damage, because kernels are exposed to physical damages more than pods.</td>
</tr>
<tr>
<td>Store groundnut in jute sacks.</td>
<td>To ensure good ventilation and low humidity.</td>
</tr>
<tr>
<td>Store groundnut in 7.5 percent moisture content at 10c and 65 RH.</td>
<td>Controls aflatoxin contamination.</td>
</tr>
<tr>
<td>Storeroom should be cleaned.</td>
<td>Unclean storerooms may create a good environment for insects, which may cause biological damages in pods.</td>
</tr>
<tr>
<td>Avoiding mixing produce in the same storeroom.</td>
<td>Other crops storing with groundnut may increase the risk of insect infestation.</td>
</tr>
<tr>
<td>Allow air circulation.</td>
<td>To remove heat, because high temperature increases incidence of aflatoxin contamination in groundnut.</td>
</tr>
</tbody>
</table>
### Table 7.2 Drying skills development scheme to reduce and/or prevent aflatoxin contamination in groundnut.

<table>
<thead>
<tr>
<th>Educational objectives</th>
<th>Information</th>
<th>Marketing extension technique</th>
<th>Extension’s Targeted clients</th>
<th>Places of execution of extension activities</th>
<th>Communication sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>To make the groundnut producer able to dry their groundnut efficiently</td>
<td>1- Plants should gathered in piles, in which the plants are turned upside down and the pods are on the air. 2- Plants should be inverted in long raw, with pods exposed to full sunlight. Pods shouldn’t be oriented outside during drying process to avoid rats and mice problem.</td>
<td>1-Demonstration. 2-study tours. 3-Written information. 4-Talks and seminars with audiovisual illustration by extension officer.</td>
<td>Groundnut producers.</td>
<td>1- In the farmers own farms. 2- In any meeting place in the village.</td>
<td>1-Marketing extension officers. 2-Guest resource people &amp; SMSs.</td>
</tr>
</tbody>
</table>
Table 7.3 Harvesting skills development scheme to reduce and/or prevent aflatoxin contamination in groundnut.

<table>
<thead>
<tr>
<th>Educational objectives</th>
<th>Information</th>
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<th>Places of execution of extension activities</th>
<th>Communication sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>To make the groundnut producer more aware about the appropriate time and technique of groundnut harvesting.</td>
<td>1-Harvest the groundnut after three months of planting to avoid over maturity. 2-Harvest the groundnut in sandy soils by hands when the soil is still moist. 3- Careful use of hand tools such as Elnagama and Eltoria in dry sand soil or mixed soil.</td>
<td>1-Demonstration. 2-Talks and seminars with audiovisual illustration by extension officer. 3-Written information.</td>
<td>Groundnut producer.</td>
<td>1-In the farmers own farms. 2-In any meeting place in the village.</td>
<td>Marketing extension officers. 2-Guest resource people &amp; SMSs.</td>
</tr>
</tbody>
</table>
Table 7.4 Sorting, grading and packing skills development scheme to reduce and/or prevent aflatoxin contamination in groundnut.

<table>
<thead>
<tr>
<th>Educational objectives</th>
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<th>Marketing extension technique</th>
<th>Extension’s clients</th>
<th>Places of execution of extension activities</th>
<th>Communication sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>To teach the groundnut producer the proper way of sorting, grading and packing of their groundnuts.</td>
<td>1- Groundnut should be dried and free of shriveled and damaged pods.</td>
<td>1-Demonstration.</td>
<td>Groundnut producers.</td>
<td>1-In the farmers own farms.</td>
<td>Marketing extension officers.</td>
</tr>
<tr>
<td></td>
<td>2- Groundnut should be separated according to quality criteria or color and pod size.</td>
<td>2-study tours to marketing sheds.</td>
<td></td>
<td>2-In any meeting place in the village.</td>
<td>2-Guest resource people &amp; SMSs.</td>
</tr>
<tr>
<td></td>
<td>3-Pack groundnut in jute sacks rather than plastic ones.</td>
<td>3-Written information.</td>
<td>Village traders.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4-Talks and seminars with audiovisual illustration by extension officer.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 7.5 Storage skills development scheme to reduce and/or prevent aflatoxin contamination in groundnut.

<table>
<thead>
<tr>
<th>Educational objectives</th>
<th>Information</th>
<th>Marketing extension technique</th>
<th>Extension’s clients</th>
<th>Places of execution of extension activities</th>
<th>Communication sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>To raise the awareness of groundnut producers about the proper way of groundnut storage.</td>
<td>1-Dried selected groundnut should be stored in well ventilated place with low humidity and free of stored product pest. 2-Store groundnut in metal or bricks stores rather than huts and mud stores. 3- Groundnut should be stored as pods rather than kernels.</td>
<td>1-Demonstration. 2-Talks and seminars with audiovisual illustration by extension officer. 3-Written information. 4- Study tours to marketing sheds.</td>
<td>Groundnut producers. Village traders.</td>
<td>1-In the farmers own farms. 2-In any meeting place in the village.</td>
<td>Marketing extension officers. 2-Guest resource people &amp; SMSs. 3-Marketing officer &amp; traders.</td>
</tr>
</tbody>
</table>
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