Chapter One

INTRODUCTION

1-1 Background:

Agricultural production in the Sudan is characterized by low productivity. Improving the productivity of all crops is a main goal of the Ministry of Agriculture, adopted to satisfy the food security objectives of the national agricultural development plan. The ministry also aspires to increase the exports of the Sudanese agricultural products. The onset of the international economic crisis has necessitated the increase in the national agricultural exports. This could not be achieved without improving the agricultural productivity, quantity and quality wise. These factors motivated the government to give special attention to the agriculture in terms of giving priority to solving problems and improving the quality of work in the agricultural sector. In this regard, Ministry of Agriculture and Forestry (FMOAF) established the Technology Transfer and Extension Administration (TTEA) in order to develop agriculture and to make it successful, profitable and sustainable. TTEA had been activated to mobilize the agricultural activities, building durable Links between all stakeholders. This administration will act as spearhead for the development of agriculture in Sudan. (TTEA 1994) http://www.ttea.gov.sd/

Objectives of TTEA:

- To develop agriculture.
- To improve yield quality.
- To improve farmer income through rational exploitation of natural resources, total human prosperity via successful, profitable &sustainable agriculture.
- To enable the agricultural products to compete in the international trade markets so as to maintain food security &increase the agriculture revenues.

Wheat crop in the Sudan was traditionally grown since early history in the northern part of the Sudan. Wheat is a strategic food crop; the demand for wheat is increasing over time in urban and rural areas, included by substantial shift in consumption habits away from traditionally used sorghum. Also population growth is partly responsible for that increase, so local production could not satisfy domestic needs. With the increased demands for wheat expansion of the area was more feasible towards the southern large plains of the centre and east. The government has therefore decided to promote domestic wheat production in order to close the wheat gap. The practice of large scale production of wheat was introduced in Khartoum state by TTEA in season 2008/2009 in an area estimated to be about 25 Thousands Faddens. (TTEA 2009) http://www.ttea.gov.sd/.

The present study is designed to assess the impact of extension services and other related factors on adoption of recommended wheat

production technologies for increasing productivity, total production and farm income from producing this strategic crop.

1-2 The problem of the study:

Resource items such as land availability and productivity, the size of the labor force and level of investable capital have encouraged the viewing of the wheat crop a as a promising agricultural product in Khartoum state. However, due to the lack of adoption of modern technologies in the production wheat, the achieved results were no as promising as was been expected, and intended for identifying factors affecting involvement of the increase the production wheat.

1-3 Objectives of the study

The main objectives of the present study are to measure the impact of the extension programmes on adoption of wheat production technology in Khartoum State, in season 2008/2009, identify factors affecting involvement of farmers in 7 leading projects in the planning and implementation of the programmes planned to increase the production of wheat in the state, and To develop and test a conceptual model of causal linkages between factors related to production of wheat in Khartoum state.

The study is designed to achieve the following specific objectives:

1. To identify the target groups (wheat farmers) characteristics.
2. To compare the 7 main wheat production projects in Khartoum state in terms of variables related to wheat production and farmer characteristics.

3. To assess the means and methods of extension services used and level of participation in programme planning by farmers, and their impacts on adoption of improved wheat production technology, crop productivity, production and gross income from wheat production in the 7 projects involved in wheat production in Khartoum state.
4. To assess the level of access to the different agriculture services that are provided to farmers for production of wheat in the agricultural projects that are covered by the study.
5. To identify factors which influence the performance of the farmers in the different activities relating to wheat production.
6. To generate recommendations for improving the impact of extension services on modern practice adoption in the production of the wheat crop.

1- 4 Organization of the study:

The thesis is organized into six chapters. The present Chapter One is an introductory Chapter focusing on statement of the problem and objectives of the study. Chapter Two is devoted to review of the literature. Chapter Three includes background information about Khartoum state (project area), methodology and analytical tools of the study. The results of data analysis are presented in Chapter Four. Chapter five includes a summary of the study findings, the conclusions and recommendations.

Chapter Two

LITERATURE REVIEW

This chapter attempts to deal with different concepts and elements of agricultural extension approaches, adoption of innovation, communication methods, programme planning, implementation, monitoring, and evaluation of extension programmes, implemented for the adoption of the improved wheat production. It also reviews some writings on new technologies used in Khartoum state in the field of wheat production.

2-1 Agricultural Extension Approaches in Sudan

"Extension comes in many sizes and shapes. Although the following classification, made primarily for agriculture, is not complete and the distinctions between the types are not absolute, it gives an idea of the possibilities and opportunities that exist for the extension planner and for the policy- and decision-maker at the national level". (FAO, 1988).

2-1-1 Conventional Agricultural Extension Approach:

"In contrast to several other approaches, this approach assumes that technology and knowledge that are appropriate for local people exist but are not being used by them. The approach is usually fairly centralized and government-controlled. Success is measured in the adoption rate of recommendations and increases in national production". (FAO, 1988).

"According to Swanson, many Third World extension systems fall in this category, the objectives of this approach is to increase the national agricultural production, farm incomes and improving the quality of the life

for rural people. Target groups such as contact or demonstration farmers are often identified to increase the numbers .In this model, the agricultural extension system generally operates out of the Ministry of Agriculture and its relevant sections". (Swanson, 1998).

"The main objective of this approach is to increase production of food and export crops. Extension communication methods used by this approach include: Field visits- Agricultural extension plots- Radio programmes- Cinema films. This approach had direct impact on improving production of the differed crops especially in northern and central Sudan". (Ibrahim, 2004).

2-1-2 Training and Visit System (T and V system)

This fairly centralized approach is based on a rigorously planned schedule of visits to farmers and training of agents and subject matter specialists. Close links are maintained between research and extension. Agents are only involved in technology transfer. Success is related to increases in the production of particular crops or commodities. (FAO, 1988).

"According to Swanson (1998), the training and visit system (T and V system) is not a new extension model. It is an attempt to reform and improve the effectiveness of conventional extension organization. The World Bank has introduced this system in many Third World countries. The basic features of the T and V system that should be maintained, according to Benor and Bauxter (1984) are professionalism, a single line of command, concentration of effort, time-bound work, field and farmer orientation, regular and continuous training, and close linkages with research".

“This approach was designed on the assumption that farmers lack technical knowledge for increasing productivity, hence the solution was therefore to provide them with modern technical knowledge. The approach is based on a set of managerial and organizational principles that are of broad applicability and which, when applied together, constitute an extremely powerful managerial tool. This approach differs from the general extension by its emphasis on frequent in-service training for staff, regular visit to farmers‟ farms, promotion of extension/research linkage and improved extension management”. (Agricultural extension and advisory services worldwide, 2012)

“This approach was introduced mainly in the Rahad and New Halfa Schemes by injecting it to inspection system (commodity approach), which was already working there. It was later introduced to different parts of the country including the Blue Nile Corporation, Khartoum State. The main communication methods used by this approach were: - The monthly workshops - Training sessions - Field's days - On- farm trials - Field and home visits – Demonstrations - Radio and television programmes. The implementation of the T and V approach in the irrigated corporations of Rahad and New Halfa had direct impact on improving formal linkage with research. Also it had direct impact on increasing production of sorghum, groundnut, cotton and vegetable crops”. (Ibrahim, 2004).

2-1-3 Commodity Development and Production System

The key characteristic of this approach groups all the functions for increased production - extension, research, input supply, marketing and prices - under one administration. Extension is fairly centralized and is oriented towards one commodity or crop and the agent has many functions. (FAO, 1988).

According to Swanson (1998), "the objective of the commodity development and production system is to produce and market relatively high value commodities efficiently and effectively". Links among researchers, input suppliers and farmers, are generally well organized. A parastatal body usually controls technology development and transfer, as well as marketing. Quality control is critical and extension agents frequently provide technical advice and inputs simultaneously.

“One of its disadvantages is that extension content is limited to technical and administrative or commercial aspect of the particular commodity or crop. Farmers become dependent on commodity organizations for advice, inputs and sale of crops”. (Agricultural extension and advisory services worldwide, 2012)

“This approach utilizes different kinds of communication methods that include: Field visits - Group meetings - Home visits - Officer visits – Workshops - Campaigns. The commodity approach was successful to some extent in improving the production of the cotton crop but failed to improve the production of other crops such as sorghum, groundnut and vegetables. (Ibrahim, 2004).

2-1-4 Integrated Agricultural Development Programmes

According to Swanson (1998), "these programs are often donor-assisted projects with their own management and technical support systems. They are usually production- oriented and emphasize an integrated approach, often in a specific geographic area. Input supply, credit, extension, marketing and other agric-services are provided".

"This approach was introduced in Sudan in 1986 and was financed by the German Agency for Technical Cooperation (GTZ). It was introduced with the aim of improving vegetables and fruits production and to promote the concept of IPM among farmers. The approach was taken to most states of Sudan including Khartoum, Sinnar, Blue Nile, Gazira and Northern state. The communication extension methods used in this approach are: - Home and field visits - On- farm trials - Field day - Pam pelts. The approach was able to achieve fruitful results and made a significant positive change regarding fruit and vegetable production". (Ibrahim, 2004).

2-1-5 Integrated Rural Development Programmes

"This approach concentrates efforts on a particular location, for a specific time period, often with outside resources. Part of its purpose is often to demonstrate techniques and methods that could be extended and sustained after the project period. Change in the short term is often a measure of success". (FAO, 1988). As Swanson, (1998) explained:

> These participatory rural development schemes blend the community development and the Animation Rural Approach of

Francophone Africa. Approaches continue to reflect a broader concept of rural development; so, the concern about these projects should include an income-producing component, probably involving new agricultural technology. At the same time, there continues to be a strong emphasis on the broad-based participation of the rural poor in planning, implementing, and evaluation programs. These efforts are also clearly designed to enable rural people to strengthen their indigenous institutions. Economic and social objectives are promoted along with increasing agricultural output which is expected to produce the new income that will support and enhance social objectives, in addition to increased participation as a central concern of these programs, particularly to increase self- reliance and local initiative. These rural development programs also pursue objectives such as improved health, nutrition, and basic education. Most rural development programs are aimed at the rural poor. One approach that can be used in initiating an integrated rural development program is to establish a pilot project in the target area.

The purpose of the pilot project is to work out the methodology of establishing a rural development program. Generalists serve as facilitators to involve the rural poor in program planning, implementation and evaluation, while specialists work directly with small farmers to develop, test and demonstrate improved agricultural technology.

Ibrahim, (2004) argued “this approach was introduced in the area of Jabel Marra from 1980 to 1995 financed by Arab Development Fund (ADF) and the European Economic Committee (EEC). This approach which was applied comprises seven components namely: agricultural extension and credit, adaptive research, community development, engineering, finance, administration and monitoring and evaluation. The main objective of this approach was to apply integrated rural development in Jebel Mara area”.

2-1-6 University- Organized Agricultural Extension

According to Swanson (1998), the United States has the most comprehensive example of this system, which is a cooperative effort among federal, state and local governments using the land- grant to universities. In his words, "the primary goal of this approach is to conduct educational programs in selected subject matter areas to help clientele solve problems in a way that is socially desirable and personally satisfying".

2-1-7 The agricultural extension participatory approach:

“This approach often focuses on the expressed needs of farmers' groups and its goal is increased production and an improved quality of rural life. Implementation is often decentralized and flexible. Success is measured by the numbers of farmers actively participating and the sustainability of local extension organizations”. (FAO, 1988).

“For this approach to work well, extension agents need not only agricultural expertise, but also good analytical, pedagogical, and facilitating skills (en-ext). What makes this approach participatory is that farmers are the principal decision-makers in defining goals, planning, implementing, and evaluating

development activities. This helps in strengthening farmers' problem-solving abilities from the start. In relation to community development, the existence of a local government and a decentralized administration is a precondition". (Agricultural extension and advisory services worldwide, 2012)

2-1-8 The farming systems development approach:

"A key characteristic of this type of extension is its systems or holistic approach at the local level. Close ties with research are required and technology for local needs is developed locally through an iterative process involving local people. Success is measured by the extent to which local people adopt and continue to use technologies developed by the programme". (FAO, 1988).

2-1-9 The cost-sharing approach:

"This approach assumes that cost-sharing with local people (who do not have the means to pay the full cost) will promote a programme that is more likely to meet local situations and where extension agents are more accountable to local interests. Its purpose is to provide advice and information to facilitate farmers' self-improvement. Success is often measured by the willingness to pay". (FAO, 1988).

2-1-10 The educational institution approach:

"This approach uses educational institutions which have technical knowledge and some research ability to provide extension services for rural people. Implementation and planning are often controlled by those who

determine school curricula. The emphasis is often on the transfer of technical knowledge". (FAO, 1988).

2-2 Adoption and Innovation:

2-2-1 Diffusion:

Rogers defined diffusion, as "Diffusion is the process by which an innovation is communicated through certain channels over time among the members of social system. It is special type of communication, in that the messages are concerned with new ideas. Communication is a process in which participants create and share information with one another in order to reach a mutual understanding". Rogers (2003)

"So diffusion is a special type of communication in which the messages are concerned with a new idea. Diffusion is a kind of social change, defined as the process by which alteration occurs in the structure and function of social system". Rogers (2003)

Also Rogers (2003), defines diffusion as "the process by which an innovation is communicated through certain channels over time among the members of social systems".

The diffusion process consists of to four main elements:

1- The Innovation:

"An innovation is an idea, practice, or object that is perceived as new by an individual or other unit of adoption". Rogers (2003)

2- Communication channels:

"Diffusion is a particular type of communication in which the information that is exchanged is concerned with new ideas. The essence of the diffusion process is the information exchange by which one individual communicates a new idea to one or several other individuals". Rogers (2003)

3- Time:

"Time is an obvious aspect of any communication process, but most communication research does not deal with it explicitly. Perhaps it is in a fundamental concept that cannot be explained in terms of something more than fundamental". Rogers (2003).

4- Social system:

"A social system is defined as a set of interrelated units that are engaged in joint problem solving to accomplish a common goal. The members or units of a social system may be individuals, information groups, organizations, and/or subsystems". Rogers (2003)

"Diffusion refers to the spread of something, such as a story or an infection, through a population. One way this can happen is through simultaneous invention. One way things can diffuse is through some kind of broadcasting such as a radio station broadcasting the news. Another way is via word – of – mouth: person to person transmission". (www. Analytictech.com/networks/diffusion).

2-2-2 The Innovation:

According to Rogers (1995), "the innovation decision process is the process through which an innovation (or other decision-making unit) passes from first knowledge of an innovation to forming an attitude toward the

innovation, to a decision to adopt or reject, to implementation of the new idea and confirmation of this decision.

We conceptualize five main stages in the process: knowledge, persuasion, decision, implementation and confirmation". Rogers (1995), Conceives these five stages as follows: -

1- Knowledge: -

"In this stage the individual is first exposed to an innovation but lacks information about the innovation. It should be noted that during this stage of the process the individual has not been inspired to find more information about the innovation". Rogers (1995)

2- Persuasion:

"In this stage the individual is interested in the innovation and actively seeks information/detail about the innovations". Rogers (1995)

3- Decision:

"Decision occurs through an individual or other decision-making unit engaged in activities that lead to a choice to adopt or reject the innovation". Rogers (1995)

4- Implementation:

"In this stage the individual employs the innovation to varying degree depending on the situation. During this stage the individual determines the usefulness of the innovation and may search further information about it". Rogers (1995)

5- Confirmation:

"In this stage the individual finalizes his decision to continue using the innovation and may use the innovation to its fullest potential". Rogers (1995)

2-2-3 Adoption of Innovations

"Adoption of innovations, involves a mental process through which an individual passes from first hearing about an innovation to final adoption" (Rogers, 1995).

"The adoption process, as a decision-making process goes through a number of mental stages before making a final decision to adopt an innovation". Fregene, T. (2008).

2-2-3-1 Rate of Adoption

As defined by Rogers (1995), "Rate of adoption is the relative speed, which an innovation is adopted by members of a social system. It is generally measured as the number of individuals who adopt a new idea in a specified period. So rate of adoption is a numerical indicant of the steepness of the adoption curve for an innovation" (Rogers, 1995).

> Based on observations of farmer's behavior (earliness or lateness of adoption), it is possible to classify farmers as possessing more or less of that trait. Those few who are first to try out a new idea are called Innovators. If the new idea survives for an appreciable length of time and is accepted by more than the first few, one can identify a second category of farmers, here called Early Adopters. Then, if the new idea continues to spread, the bulk of farmers who ultimately accept the new idea can be classified as Early and Late Majority, depending on the time (relatively early or late) at which they make the decision to adopt. Finally, some minority of farmers

accepts the idea very late, and conventionally called Laggards (Swanson, 1984).

2-2-3-2 Adopter Categories:

Rogers defines an adoption as "a classification of individuals within asocial system on the basis of innovativeness. With regards to diffusion of innovation Roger suggests a total of five categories of adopters in order to standardize the usage of adopter categories in diffusion research. It should be noted that the adoption usually appears as a normal of distribution curve when plotted over length of time. The categories of adopters are: innovators, early adopters, early majority, late majority, and laggards" (Rogers, 1995).

1- **Innovators:**

As defined by Rogers, innovators are the first individuals to adopt an innovation. Innovators are willing to take risks, youngest in age, have the highest social class, have great financial lucidity, very social and have direct contact with scientific sources and interaction with other innovators. The innovators must also be willing to accept an occasional setback when a new idea proves unsuccessful, as inevitably happens. While an innovator may not be respected by other members of a local system, the innovator plays an important role in the diffusion process: that of launching the new idea in the system by importing the innovation from outside of the system's boundaries. Thus, the innovator plays a great key role in the flow of new ideas into a system. (Rogers, 2003).

2- Early Adopters:

"This is the second fastest category of individuals who adopt an innovation. These individuals have the highest degree of idea about

leadership among the other adopter categories. Early adopters are typically younger in age, have more financial lucidity advanced education, and are more socially forward than late adopters". Rogers (1995).

"The early adopters have less uncertainty about a new idea actually adopt , and then conveying a subjective evaluation of innovation to near peers through interpersonal networks. In one sense, early adopters put their stamp of approval on a new idea by adopting it". (Rogers, 2003).

3- Early Majority:

The early majority adopt ideas just before the average member of a system. The early majority's unique location between the very early and the relatively late to adopt makes them an important link in the diffusion process. They provide interconnectedness in the system's interpersonal networks. The early majority may deliberate for some time before completely adopting a new idea. Early majority tend to be slower in the adoption process have above average social status, contact with early adopters. They follow with deliberate willingness in adopting innovations but seldom lead. (Rogers,2003).

4- Late Majority:

Rogers explain individuals in this category will adopt an innovation after the average members of the society. These individuals approach an innovation with a high degree of skepticism and after the majority of society has adopted the innovation. Late majority are typically about an innovation, have below average social status, very little financial lucidity,

in contact with others in late majority and early majority, very little idea about leadership. (Rogers, 2003).

5- **Laggards**:

According to Rogers (2003). “Laggards are the last in a social system to adopt an innovation. They possess almost no idea about leadership. The point of reference for the laggard is the past. Decisions are often made in terms of what has been done previously, and these individuals interact primarily with others. They also have relatively traditional values. The laggards have lowest social status, lowest financial fluidity, oldest of all other adopters, in contact with only family and close friends, very little to no idea about leadership”.

2-3 Communication

“Communication is “a process of transferring information and trends from the source to the receiver” (Rogers and shoemaker, 1971).Communication is “a process in which participants create and share information with one another in order to reach a mutual understanding” (Rogers, 1995).Another definition of “communication channel is the means by which a message gets from a source to a receiver” (Rogers, 1995).

2-3-1 Types of Communication Channels

According to Rogers (2003), “researchers categorize communication channels as either: 1) Interpersonal channels 2) Mass media channels.

Interpersonal channels involve a face-to-face exchange between two or more individuals. These channels have greater effectiveness in dealing with resistance or apathy on the part of the communicators. Mass media channel are those means of transmitting messages that involve a mass media, such as

radio, television, newspapers, which enable a source of one or a few individuals to reach an audience of many individuals".

2-3-2 Cosmopolite Versus Localite Channels

As suggested by Rogers (2003), "Cosmopolite channels are relatively more important at the knowledge stage, and localite channels are relatively more important at the persuasion stage in the innovation-decision process" (Rogers, 2003).

2-3-3 An Ideal Sequence of Use of Communication Channels

Rogers (2003) "investigated the importance of interpersonal and mass media channels in the innovation-decision process with farmers and found that if the probability of adoption were to be maximized, communication channels must be used in an ideal time sequence, progressing from mass media to interpersonal channels".

2-3-4 Communication Processes:

"It is useful to conceptualize communication processes in terms of the S- M- C- R model. The letters, in order, stand for Sender or source, Message, Channel, and Receiver. The imagery of the electronic mass media which is conveyed by those terms is not inappropriate, but communication among human beings is by no means as simple as the mass media imagery might imply". (Swanson, 1984).

> The extension worker as a teacher must know his or her audience, as was indicated in the preceding section. An extension worker must, of course, rely on others for information to initiate communication with a farm audience. One could trace such a chain of origins for information back almost endlessly, but for practical purposes it is useful to view

> extension personnel not only as one of many initiators of communication with farmers but also, in a tactical sense, as key initiators (senders) in the development process. The message prepared by an extension worker must be clear as to its purpose. Objectives must be specified; the content of the message must be relevant to the audience and directly linked to the intent or purpose of the communication. In addition, the treatment of the message must be such as to be intelligible to the intended audience. Channels of communication are the various methods available to any communicator in reaching an audience with a message. Written communication has obvious limitations in those Third World setting where literacy levels are low, but cannot be rejected out-of-hand in view of the considerable evidence that print messages are read to non-literates in areas of low literacy. (Swanson, 1984).

"To be effective, result demonstrations require the use of both visual and spoken communication, and can easily benefit from the use of written material as well; a combination of methods, in other words, is the ideal". (Swanson, 1984).

> As suggested by Swanson, one of least appreciated contracts between farmers in industrialized settings and less developed settings is that there is an enormous amount of redundancy in both messages and channel usage in industrial societies. Farmers are exposed to similar information from a variety of senders in both the public and private sectors. The receiver of greatest care is the farmer. Several items are listed under the

receiver heading, which essentially describes the desired impact of a message on a farmer. The items listed are intended to determine the farmer's mental and physical responses, evoked by effective communication. They can be thought of as stages in the process of adoption of improved agricultural technology (Rogers, 1995), which are the preferred outcomes of the communication process. Finally, farmers who adopt a new idea continue to seek information about the merits of their adoption decision, to assess whether the intended improvement performs as expected.

All too often the feedback process is simply allowed to happen and is treated as a relatively passive aspect of the communication process, with major attention being given to the extension worker as initiator of the important messages in the process. In the discussion, which follows, researchers, extension personnel, and farmers are each, in turn, senders and receivers of messages. In other words, the knowledge- transfer process is viewed from a broader perspective. (Swanson, 1984).

2-4 **Planning of extension Programmes:**

According to Lyle, M. JaneAnn, S. Linda, B. Wendy, W. (2008).

Planning is the key management function-determining of any extension workers. It is the process of determining in advance what should be accomplished, when, by whom, how, and at what cost. Regardless of whether we are planning long- term programme priorities or a two – hour meeting, the planning aspects of success and productivity are essential. Planning is the

process of determining the organization`s goal and objective and how to choose a course of action from available alternatives. Planning is the process of determining organizational aims, developing premises about the current activities required to transform plans into action, and evaluating the outcome. The type of planning that managers engage in, will depend on their level of the organization, the size and type of the organization. Generally there are four major types of planning: strategic, tactical, contingency, and managerial.

"Strategic planning involves determining organizational goals and how to achieve them. Tactical planning is concerned with implementing the strategic plans and involves middle and lower management. Contingency planning anticipates possible problems or changes that may occur in the future and prepares to deal with them effectively when they arise". (Marshall,1992) cited by (M. W. Waldron and etal, 1997).

Managerial planning is usually considered as micro level planning. It helps in combining resources to fulfil the overall objectives of the extension organization.

2-4-1 Basic steps of programme planning:

1- Needs assessment and goal identification: allows extension programmeming to be guided by social needs. State-wide initiative results from prioritizing local and state needs assessment. Countries assess local needs to identify how they relate to the State-wide needs. Focus

needs assessment helps determine State-wide and local goals and priorities.

2- Identify resources and restraints: bring a planning effort into perspective and ensures that planning is performed with people – not for people. In addition, it ensures that the dimensions of the effect are understood.

3- Determining objectives: is the process of analyzing the goal statement and breaking it into workable parts around which programs and activities are developed. Objectives and the intended results/ impacts on the targeted clientele must be measureable.

4- Designing the program: Focuses on creating the methods and activities that bring about the desired outcome stated in the objectives.

5- Program implementation: activates the goal statement, the objectives, the methods, and the activities previously planned.

6- Evaluation: can be used at any step in the program planning and implementation processes. Impact evaluation is used to determine if programmed goals and objectives, identify program impact on individuals and communities, provide documentation for stakeholders, and meet accountability requirements. (Lyle et al, 2008)

2-5 Implementations:

"The success of any strategy depends on the ability to have it implemented. It must provide sufficient information to enable people to envisage it. It should also give an indication of the issues that have to be looked at for the development of the land. It is also important to stick to the broad concept of the strategy whilst allowing for minor changes of direction as the strategy is being implemented". (Australian rural planning 1998)

2-6 Monitoring:

Monitoring is about collecting information that will help you answer questions about your project.

Monitoring information is collected at specific times: daily, monthly or quarterly. To get good advice on how your database can best serve your information needs, talk to another project manager with a good management information system and to database expert, if possible.

It is important to be familiar with the data protection act. Make sure data is used for its intended purpose. If personal information is kept about individual service users, make sure that they know exactly what the evaluation is for, what data exist that they can have access to, in order to check its accuracy, and that the project will preserve its confidentiality.

Here are some basic points for successful monitoring:

- systems enter into everyday activities, collecting data at the most natural point must be observed.
- gets commitment from those collecting the information, by explaining why they are doing it?
- make sure that every one responsible for monitoring has clear and consistent guidelines.
- make sure that monitoring records are completed fully and accurately – most people may not regard it as a high-priority activity.
- check that the project is not collecting the same piece of information more than once. (FAO, 1994).

When evaluating, you will use this information, but often you will need to carry out additional data gathering. Your monitoring information will probably suggest further questions that need answers. You need to think clearly about where the focus of the evaluation will be and who and where you want to obtain information from. Make sure you set enough time a side for this additional information gathering. Questionnaires take time to develop, and should be tested with a small sample from your target group to see if they will capture the information you want. Interviews take time to organise and even longer to write up and analyse. (FAO, 1994).

According to Oxfam (2010), monitoring is a way of helping us find out the strengths and weaknesses of our work so that we can then adjust our plans and activities accordingly.

The terms monitoring and evaluation are often linked. Although both are ways of assessing the effectiveness of what we are doing and demonstrating accountability, there are, in practice, important differences between the two:

- Monitoring is a more continuous process than evaluation. It's a constant element within any project, whereas an evaluation happens at certain points and for a certain period of time.

- Monitoring is away of checking that our work is going according to plan, and that the project`s activities are effectively meeting its objectives. Evaluation is a broader assessment of past experience which will determine whether the project`s overall objectives and goals have been achieved and which progress can be used to improve future planning and practise.

- Monitoring focuses on the project`s progress towards its goals. Evaluation may actually question the goals themselves and the methods which were chosen to reach them.

"The purpose of monitoring is to measure the progress and effectiveness of plans. This is done by collecting different kinds of information from different sources on a continuous and systematic basis". (Oxfam 2010).

2-7 Evaluation of Extension programmes

Swanson (1998) defined "extension evaluation as assessing the value or potential value of extension programmes. The definition attempts to be as broad as possible, and emphasizes the continuous and systematic nature of evaluation. With regard to the role of objectives in evaluation, a major concern is usually the extent to which the programme met some or all of its gaols or objectives".

"It is a process, which enables the administrator to describe the effects of his programme and thereby make progressive adjustments in order to reach his goal more effectively. Programme evaluation is the determination of the extent to which the desired objectives have been attained or the amount of movement that has been made in the desired direction". (tamil nadu agricultural university, 2011)

2-7-1 Types of Evaluation:

Swanson (1998), divided the evaluation to many types: -

1- **Informal and formal evaluation:**

Informal evaluation is a systematic evaluation, the criteria and evidences of which, are used in making judgments implicit. They can, therefore, be biased and misleading.

The more systematic the evaluation, the more likely it will contribute to making useful decisions about an extension programme. Thus, we should at all times attempt to make our evaluations more systematic and more formal.

2- Formative and summative Evaluation:

In the past, the emphasis has been on summative evaluations that were conducted after the completion of the programme to assess the accomplishments and weather intended objectives will be achieved. Nowadays, more and more attention is being paid to formative evaluations that are conducted before programme implementation. Such evaluations provide early feedback on program weaknesses, which can then be used to modify or adjust the remaining stages of programme.

Conceptually, monitoring and evaluation correspond in many respects to formative and summative evaluation. However, in extension, the former has been most extensively used in conjunction with a specific monitoring system developed for the training and visit system.

Monitoring is defined as the gathering of information on utilization of project inputs, unfolding of project activities, timely generation of project outputs, and circumstances that are critical to the effective implementation of the project.

3. Distinction between on-going evaluation and ex-post evaluation is as follows:

- On- going evaluation: is an action-oriented analysis of project effects and impacts, compared to anticipations, which is usually made during implementation.

- Ex- post evaluation: would resume this effort several years after completion of the investment, to review comprehensively the experience and impact of a project as a basis for future policy formation and project design. (Swanson 1998)

2-7-2 Basic steps in evaluation of extension programmes:

According to Bennett (1973) cited by Swanson (1998), series of steps can be identified which are basic to all formal evaluations:

1- Develop an evaluation plan:

An evaluation plan is important for three major reasons. First of all, resources to conduct an evaluation are always limited, and adjustments will constantly have to be made between what is the best or ideal way to conduct such an exercise of extension and what is possible, given the limitations existing in the situation. Secondly, planning will also help to focus the evaluation on questions that are of concern to relevant audiences.

An evaluation plan will give the relevant audiences an opportunity to be involved so that the evaluation can address their questions and concerns. Thirdly, the existence of an evaluation plan will facilitate getting useful input from everyone concerned.

2- Consider the need for the evaluation:

The major purpose of evaluations is to assist in program decisions. Formal evaluations are worth doing only if they have a chance of affecting such decisions. (Bennett, 1973) cited by Swanson (1998)

2-7-3 Using evaluation for organizational planning and management:

The evaluation can provide decision makers with knowledge and information to make informed choices. Your evaluation should show which parts of the project are working, for what people and in what circumstances, and provide a warning if something is going wrong.

The evaluation will also provide information for your next year plan. It will help you to review your objectives.

The evaluation may give you clearer information about who is using your service and your group members, or who you are reaching with your information or publicity.

Evaluation should give you some important information about how you deliver your services to users, how this affects user satisfaction and how service delivery affects the outcomes for users.

Evaluation should not just look at the results of your activities, but should relate these to the project's inputs.

Evaluation can play a key role in highlighting the effect that wider social structure and policies have on your own work and on the lives of the people you work with. There is an important role for evaluation as well as operational

planning. The strategic planning process starts when you have analyzed monitoring and evaluation data. (FAO, 1994).

2-8 Agriculture in Sudan

Sudan is country in Africa. The Nile River and its tributaries are the life of this very hot desert country. People have lived in Sudan for thousands of years farming by the Nile banks and herding livestock.

2-8-1 The land

According to FAO (1994), Sudan is the huge country. The marking feature of the country is the Nile River, formed by the White Nile and Blue Nile confluence in the capital city. In general the country is flat. The exceptions are the coastal Red Sea Mountains in the east, the Nuba Mountains, and the far western mountains. Northern Sudan is very dry, consisting of large expanses of desert and arid planes. Southern Sudan contains large areas of rain forests and swamps making it much more adaptable for farming.

About one-third of the total area of Africa's largest country is suitable for agricultural development. Abundant rainfall in the south permits both agriculture and grazing grounds for the large herds owned by nomadic tribes. In the north, along the banks of the Nile and other rivers, irrigation farming prevails, the area of total arable land was estimated as 16.9 million hectares (41.8 million acres) in 1998, and about 1.9 million hectares (4.7

million acres) were irrigated. Principal cash crops are cotton, gum Arabic, sesame, peanuts, sugar, dates, citrus, fruits, mangoes, coffee, and tobacco; the main subsistence crops are sorghum, millet, wheat, beans, cowpeas, pulses, corn, and barely. Cotton is the principal export crop and an essential component of country's economy. In 2001, agricultural products accounted for 21.9% of imports and 19.2% of exports; there was an agricultural trade deficit of $ 24.5 million.

2-8-2 The climate:

According to FAO (1994) ,Sudan lies between latitudes 4.0 N and 22.0 N, and longitudes 22.0 E and 36.0 E. The climate varies from hot tropical in the south and south – east (rainfall is between 1.000 mm and 1.500 mm, distributed throughout the year) to semi – arid tropical in southern Blue Nile zone (summer rains between 300 mm and 800 mm) and hot sub – tropical desert (rainfall less than 100 mm) in the north.

There is a dry season and a rainy season. The length of the rainy season is largely determined by how far the distance from the north. The extreme south of Sudan normally has nine months rainy season while a city like Atbara in the North is lucky if it gets more than a week of showers. Khartoum usually has two months rainy season roughly lasting throughout July and August. Temperatures in Sudan are highest in May and June, which are also the common season for sandstorms.

Average daily highs range between 100 F and 110 F with an occasional day temperature 120's F. Because the country is

mostly desert there is usually a large difference between day time and night time temperatures. In Khartoum a January day might have a maximum of 80 F and a minimum of 45 F at night.

Sudan has one of the most ethnically diverse populations in the world. Over four hundred ethnic groups each has its own language which is used alongside the common language (Arabic). Greater Khartoum the largest city in the country has a population of about six million people. Sudan's current total population is around thirty five million people. Today Sudan is progressing towards becoming a modern country attempting hardly to find its place in the international community. (FAO, 1994)

2-9 Wheat Production in the World: -

"Wheat was one of the first domesticated food crops and for 8 000 years has been the basic staple food of the major civilizations of Europe, West Asia and North Africa. Today, wheat is grown on more land area than any other commercial crop and continues to be the most important food grain source for humans. Its production leads all crops, including rice, maize and potatoes. (FAO, 2002).

Although the crop is most successful between the latitudes of 30° and 60°N and 27° and 40°S" (Nuttonson, 1955) cited by (FAO, 2002). "Wheat can be grown beyond these limits, from within the Arctic Circle to higher elevations near the equator. Development research by the International Maize and Wheat

Improvement Center (CIMMYT) during the past two decades" (Saunders and Hettel, 1994) cited by (FAO, 2002)

"Wheat is also a popular source of animal feed, particularly in years where harvests are adversely affected by rain and significant quantities of the grain are made unsuitable for food use. Such low-grade grain is often used by industry to make adhesives, paper additives, several other products and even in the production of alcohol" (FAO, 2002).

2-9-1 Wheat utilization: -

World wheat utilization or consumption, defined as food, feed, seed and processed uses, as well as waste, has remained near 550 million tons since 1990. Consumption worldwide has increased rapidly since the early 1960s. Wheat consumption in developing countries rose 35 percent during the period 1963.1976. This primarily resulted from increased urbanization and an associated shift in tastes and preferences to wheat over rice and coarse grains, such as maize and sorghum. Also important was the increased adoption of wheat as a food in countries that had consumed little wheat in the past. The influence of urbanization on wheat consumption was most clearly seen in sub-Saharan Africa where per caput consumption growth rates in the late 1970s and early 1980s exceeded 6 percent annually. Annual consumption growth rates in those areas have now decelerated to near zero or less, while average per caput consumption remains near 10 kg/year. Urban

consumers tend to prefer convenience-type foods that require little or no preparation (Curtis, 1982) cited by (FAO, 2002).

2-9-2 Wheat production in the future:

"The world population growth rate from 1993 to 2000 is estimated at 1.5 percent, while the growth rate of wheat production from 1985 to 1995 was 0.9 percent" (CIMMYT, 1996) cited by (FAO, 2002).

"If population growth continues to double the growth of wheat production, there will likely be serious difficulties in maintaining a wheat food supply for future generations. World population was projected to be 5.8 billion people at the end of 1997 and is expected to reach 7.9 billion by the year 2025, or roughly a 35 percent increase" (United States Census Bureau, 1998) cited by (FAO, 2002).

In simplistic terms and assuming little or no change in world per caput consumption of wheat, a projection of 786 million tonnes of wheat will be required annually for human use in the year 2025, an annual production increase of 204 million tonnes above production in 1997. This underscores the need to rapidly and continuously increase production. Greater wheat production can be achieved in two ways: (i) by expanding the wheat area; and (ii) by improving the yield per unit area sown. In addition, reducing pre- and post-harvest losses would make more wheat available for consumption. (FAO, 2002).

2-9-3 Yield improvement

Crop yields are dependent on interactions of socio-economical, biological, technological and ecological factors. Considerable controversy exists among scientists regarding the achievements that can be made to further increase wheat yield per unit of area. A large gap exists between yields that have been accomplished in experimental fields versus those attained in farmers' fields. The absolute yield, based on genetic potential, is projected to be 20 tonnes/ha" (Hanson *et al*., 1982) cited by (FAO, 2002). "The highest commercial attainable yield reported is 14 tonnes/ha under a given environment, location and year" (Cook and Veseth, 1992) cited by (FAO, 2002). In contrast, the wheat yield average for the world during the period 1993.1995 was 2.5 tonnes/ha. Closing the yield gap must, of necessity, be one of the major goals of organizations involved with world food policy and wheat research for the future. Current research to improve wheat yields covers a broad front and includes further mixing of germplasm through crossing, interspecific and intergeneric hybridization, biotechnology techniques, hybrid wheat, basic studies on the physiology of the wheat plant and on the host-plant relationships of various pests that attack it and numerous other important research avenues. (FAO, 2002).

2-10 Wheat Production in Sudan: -

Sudan differs from many other developing countries in that it is not overpopulated, and the land is sufficient in quantity and quality to provide employment or self – employment for all its people. Before 1960, Sudan grew wheat only in northern section of the Nile valley, and, even there only on limited scale. Because of local land shortage, and because of the large cost of irrigation in the north, the government decided to grow wheat in the Gezira Scheme, although environmental and climatic conditions there are less favourable for wheat than in the north. At the same time wheat cultivation was extended to New Halfa Agricultural Scheme in the east, on the Atbara River.

Domestic production of wheat has been too small to meet growing needs, and imports cover the deficit. In 1972 the government adopted the policy of self – sufficiency in wheat as national goal, but maintained cheap selling prices, which discouraged wheat production. In 1974 the government agreed to raise the purchasing price to compensate for production costs. Sudan's farmers responded by growing more wheat, and in 1977/78 they produced two thirds of Sudan's wheat requirements. However, wheat prices increased during the 1980s as the result of the deterioration of international economic conditions, escalation of fuel costs and decline in the productivity of wheat in the Gazera Scheme. The government abandoned its goal of self – sufficiency in wheat, preferring instead to focus on the output of export crops. Sudan's wheat

policy now is to rely only partially on domestic production, at a level commensurate with food security requirements, while importing the rest of the required quantity. At the same time, the growth of personal incomes and cities is changing the preferences of consumers. Therefore, wheat imports, too, have increased. Hassan, R. et al (1993).

On the other hand, the research centers have provided technologies that have resulted in tangible wheat yield improvements. However, despite government support and increase in the wheat yield potential, wheat profitability for producers has been relatively low. Questions arise as to the competitiveness of wheat and its production prospects if farmers in irrigated schemes are to make their own decision on the desirable crop mix. The issue gains utmost importance by the recent government policies that aim at greater liberalization in the production process and a consistent removal of subsidies on wheat and bread prices. Wheat demand in Sudan is difficult to estimate due to continued price fluctuations and the persistence of short supplies whether of domestic or external origin. However, it is evident that a substantial part of the demand has remained unsatisfied. This is especially apparent in urban areas where the bulk of the wheat is consumed. The rising wheat demand is, however, reflected in actual wheat consumption, which has increased enormously during the last three decades. The current average per capita consumption is over 33 kg as compared to 20 kg in 1971 and 6 kg in the early

1960s. Sudan currently consumes about 850.000 metric tons of local production for the first time during the 1991 – 92 seasons. Faki et al, (1993).

"The driving force for wheat demand in Sudan is urbanization, rising incomes, and population growth, according to projections based on 2.8 and 5% rates of growth in population and income, respectively". (FAO, 2002).

"The government Quarter Century Plan (2002-2027), among others, focuses on i) increased production of food crops ii) increased agricultural products and reduced imports and iii) introduction of new crops. The plan is to double the area under irrigation to reach 4.2 million hectares. Furthermore, the government approved an investment encouragement act where priorities are given to projects that address food security by increasing wheat production, focus on least developed areas, promote export capability of the country, aim at integrated rural development and increase job opportunity". (Improvement of Wheat Production in the Northern State of Sudan through technology generation and transfer. Dagash et. al (2007).

2-11 Wheat Yield – limiting factors

According to Ageeb, O. (1993), wheat productivity in Sudan is affected by a number of environmental constraints, the most important of which are discussed in the following sections:

2-11-1 Temperature:

Wheat in Sudan is grown under irrigation during the dry and comparatively cool winter season, which extends from November to February. The growing season is short (90 – 100 days). In addition, the potential yield of the present commercial

cultivators is limited by high temperatures at any stage of crop development.

2-11-2 Soils:

The soil of the irrigated schemes of central and eastern Sudan is relatively uniform, fairly levelled, calcareous heavy and cracking vertisol. Drainage is impeded by its extremely low hydraulic conductivity (1.5 cm/hr). As a result, water logging is frequent in poorly managed soils. This leads to crop patchiness and low grain yield. The soil is alkaline (pH 8.5), deficient in nitrogen (300 ppm), available phosphorus (4 – 6 ppm), and probably some micronutrients (e.g. zinc), but has adequate potassium. Ageeb, O. (1993)

2-11-3 Pests and diseases:

Wheat in Sudan is vulnerable to few biotic infections that can be economically managed. Currently, wheat is free from diseases in central and northern Sudan, but in eastern Sudan where relative humidity is higher, the susceptible local varieties suffer from leaf rust and stem rust. Aphids are the major insect pests that infest wheat, when not controlled they can cause up to a 30% decrease in grain yield Rats appear sporadically and in years of outbreaks can cause heavy crop losses. Ageeb, O. (1993)

2-11-4 Weeds:

On average, weeds have no economic importance in wheat production. However, during recent years, intensification and diversification of cropping systems, drought conditions, the continuous increase in animal movement and the use of herbicides in cotton that precedes wheat in the rotation have created profound changes in the weed flora in the irrigated schemes. Perennial weeds are on the increase and other annual weeds are becoming a source of ruisance. Ageeb, O. (1993)

2-11-5 Agronomic factors:

Agronomically, national wheat yields are low (1.4 – 2.0 t/ha) and considerably below (60% lower) than the levels attained in research fields, demonstration plots, and by leading farmers. The low yields are mainly associated with low crop stand, late sowing, inadequate and uneven distribution of fertilizer, moisture stress, and delayed harvest. Ageeb, O. (1993)

2-12 Improved Wheat Production Technologies:

2-12-1 Crop Establishment:

Poor crop establishment of wheat is a major cause of low yield on the heavy clay soils, which constitute 90% of the total cropped area. Field experiments were carried out in the major wheat producing areas to test the effects of tillage system pre-sowing irrigation, machine plowing and methods of irrigation on crop establishment and grain yield of wheat. Land preparation by an off-set disc harrow was found to be the most

suitable with regard to yield, cost, and time required to prepare the land". (Salih et al. 1990) is cited by Ageeb, O. (1993).

"Application of pre-sowing irrigation seals the soil cracks improves seedbed preparation, helps towards more efficient future watering, improves crop stand, and increase wheat yields by 9 to 28%". (Ageeb 1992), cited by Ageeb, O. (1993).

"Furrow irrigation between 40 – or 60 cm ridges as compared to basin irrigation reduces crust formation and water logging hazards". (Babiker and Mohamed 1992), cited by Ageeb, O. (1993).

"Harrow – packing after seeding was introduced as a measure to increase seed – soil content and hence improve crop establishment. The results obtained so far indicate that this shortens the time for the first irrigation, but it had little positive effect on grain yield". (Dawelbeit 1992), cited by Ageeb, O. (1993).

2-12-2 Sowing Date:

"According to early research recommendations, wheat sowing should take place from mid – October to mid – November. The sowing date recommendation was then changed to be throughout November, preferably between 12 – 26 November, so that the critical reproductive phase coincides with the coldest part of the season". (Ishag and Ageeb 1991), cited by Ageeb, O. (1993).

2-12-3 Seed Rate:

"Many studies showed that on average, wide variation in seed rates has no significant effect on grain yield of wheat because of the

compensatory effects of yield components. The recommended seed rate is 119 kg/ha, but farmers being aware of the shortcomings in land preparation use 143 kg/ha". Ageeb, O. (1993).

2-12-4 Fertilizer Requirements:

The responses of wheat to the application of chemical fertilizers have been extensively studied in Sudan.

i- Nitrogen:

"Wheat yields are found to be tremendously increased (80% more than control) by application of nitrogen fertilizer" (Ageeb and Lazim 1974), cited by Ageeb, O. (1993).

Early nitrogen application effectively increased leaf area duration after ear emergence, which is reflected in higher grain yield. The benefits from nitrogen were greater with early sowing of wheat (November) because of higher nitrogen– uptake during early vegetative growth as a consequence of which nitrogen was readily available to the plants. (Khalifa et al. 1977), cited by Ageeb, O. (1993). Best returns from higher rates of nitrogen application were obtained from wheat crops sown at the optimum date. The cultivar Mexicali sown before the end of November could economically respond to 86 kg N/ha, while a December – sown crop responded to no more than 43 kg/ha. (Akasha 1978), cited by Ageeb, O. (1993).

ii- Phosphorus:

"The response of wheat to phosphorus application was found to vary with cultivar, method of application, nitrogen addition, and soil moisture. There was a general lack of response to P in the absence of applied nitrogen.

Generally, P uptake by wheat plants follows a similar pattern to that of nitrogen, but its rate of uptake was slower early in the season and faster later on. P applied with the seed gave better results than when it was broadcasted" (Akasha 1978), cited by Ageeb, O. (1993).

"The results from recent on – farm trials in the major wheat producing areas clearly demonstrated the high response of wheat to the application of fertilizer phosphorus (25 to 70% increase in yield). As a consequence, it was recommended to apply 43 kg $P_2 O_3$/ ha in addition to a basal dressing of 86 kg N/ ha in all wheat producing areas in Central Sudan" (Ageeb and Abdalla 1988, Babiker 1989, Omer 1992), cited by Ageeb, O. (1993).

iii- **Micronutrients:**

Heavy clay vertisols of central Sudan have low organic matter and high PH. Under such conditions, deficiencies of some micronutrients (Zn, Mn, Fe etc.) are likely to occur. A number of multilocation on – station and on – farm trials were carried out in the 1991 – 92 growing season to find out the response of wheat to the application of different commercial brands of foliar micronutrient fertilizers. The wheat response was highest under the controlled conditions at the station level (up to 37%) and lowest in farmer's fields (6 – 21%). The increase in yield was thought to be mainly due to the observation that wheat leaves stayed green for longer periods in the sprayed fields (Ageeb 1992), cited by Ageeb, O. (1993).

2-12-5 Water Requirement:

Estimates of daily water consumption for wheat varied widely from 3.5 to 8 mm within and between seasons. The causes of

much of this variability can be related to the prevailing weather, the stage of crop development, and level of vegetative vigor" (Farbrother 1974), cited by Ageeb (1993). "Maximum soil moisture changes wheat under cultivation in the top 40 cm. Peak demand for water occurs during stem elongation, heading, and grain formation (mid- December to the end of January). Crop factor (Et/ Eo) reaches a peak of 1.2 during heading and flowering time. When irrigated at 14 – day intervals, it used 500 mm of water per season" (Fadl 1974), cited by Ageeb, O. (1993).

"In the Northern State, wheat was found to require about 640 mm of water to produce 4 t/ha of grain" (Ahmed 1992), cited by Ageeb, O. (1993).

The research recommendation is that irrigation should be applied every 14 days during the vegetative phase and every 10 days during the reproductive phase in which case about eight irrigations are needed.

2-12-6 Weeds Control: -

"The practice was to control weeds prior to crop sowing by pre – watering or by heavy discing after heavy rains" (Babiker 1979), cited by Ageeb, O. (1993).

"However, in recent years, rainfall has been unpredictable and pre – irrigation is now rarely practiced. In most situations, wheat comes after cotton where herbicides are used, although the intensification and diversification of cropping have brought important changes in the weed flora. The perennial weeds such as *Cycondon dactylon* are increasing. In addition, other weeds such as wild sorghum are gaining importance in wheat" (Babiker 1989), cited by Ageeb, O. (1993).

"The herbicide Puma, applied at 0.071 kg a.i /ha two to four weeks after planting by ground or aerial spraying, has provided excellent and lasting control of wild sorghum" (Babiker 1991), cited by Ageeb, O. (1993).

2-13 Transfer of Improved Wheat Production Technology to Farmers' Fields:

For years, agricultural research in Sudan was dominated by on – station research translated into recommendations to enhance farm production under varied situations. This approach, although had produced tangible results in many instances, had fallen short of appreciating the real problems and constrains facing farming communities. The trend to on – farm research with farmer participation therefore emerged and continued to evolve and mature, taking full consideration of production constrains and farmers' decision – making criteria and risk awareness. The adoption of on – farm research in wheat involving a tripartite relationship between researcher, extension officer, and farmer was and still is greatly promoted by the technical interface with CIMMYT and ICARDA in the successful Nile Valley Region Program on cool – season cereals and food legumes. The Sudan component of the program is generously financed by the Royal Netherlands Government. The overall impact of the program is extremely positive. Ageeb, O. (1993).

Chapter Three

RESEARCH METHODOLOGY

3.1 Research Site

Khartoum is the capital city of Sudan in North East Africa. Over 8 million people live in Khartoum which is situated at the confluence of the Blue Nile and White Nile. Khartoum is really one of three cities in this area: Khartoum, Bahri (Khartoum North) and Omdurman. (Embassy of republic of sudan, washington 2005)

3.2 Location

Khartoum town lies along the left bank of the Blue Nile, and forms a huge triangle. Its vertex at the confluence of then two Niles, the White Nile on its west side and the Blue Nile on its east and the base bordering Gezira State some 30 K. southward. It is situated on latitude 15 36 N, and longitude 31 32 E, and it is 1352 ft. above sea level. Its population has grown to over 5 million people. Khartoum, together with the two cities, Omdurman and Khartoum North (Bahri), these cities jointly called the tri-capital, constitute the National Capital of the republic of Sudan". (Embassy of republic of Sudan, washington 2005)

3.3 Climate

The climate is mainly tropical. During summer (March - June), the temperature is quite high, with an average temperature of 38 C, with May as being the hottest month of the year. Autumn starts from mid-July and ends

on September, with a total rainfall of 167 mm; it is characterized by abundance of sandstorms. Winter starts on October and lasts up to March, it is endowed with a beautiful to moderate, dry and healthy weather, the average temperature in winter is 24 C, the ideal time for foreigners to visit Khartoum and enjoy its tourism activities (Embassy of republic of Sudan, washington 2005)

3.4 Land Forms

There is little binding vegetation in Khartoum, but going further south, the vegetation gradually changes from desert to semi-desert to savannah with long grasses and large plains.

The terrain is generally flat or gently sloping, only interrupted by occasional hills of rocky outcrops while sand dunes provide a gently undulating topography. This flat landscape is also broken by the floors and terraces of the Nile valleys and Wadis. The White Nile has a much lower gradient than the Blue Nile and consequently its terraces rise far more gently. http://www.krt.gov.sd/khartoumen.php 2013

3.5 Agriculture:

Agriculture has always been an important land use in Khartoum over the five decades, but has geographically shifted over time. Since 1958, agriculture in Khartoum has expanded by on average 172 ha per year. Thus characterized as urban agriculture which is likely to be a major contributor to the city's food supply. Khartoum state is characterized by fertile land which is estimated of about 1.8 million Feddans, equivalent to 36.5% of the total area of the state.

There are 3 types of land use:

i- The Jirouf land which extends along the banks of the Nile and flooded by river normal flow. Crops are grown without irrigation. Soils are highly fertile. Crops grown include leafy vegetables, onions, okra, garlic, radishes, cabbage and lettuce.

ii- The Gureir land is adjacent to the Jirouf land and Subject to moderately high flood. Soils are alluvial loams. They are irrigated by underground water (pumps). Crops are potatoes, tomatoes, onions, beans fodders and fruits.

iii- High terrace lands occur on the landward side of flood plain. Soils are sandy loams or sandy clay, moderately saline or alkaline. They are utilized by large public, private and cooperative agricultural schemes (100-30,000 ha). (Policy Assessment, Consultancy & Training (PACT) 2010)

Khartoum state with its unique position at the confluence of the Blue and White Niles represents an ideal location for food production, which is fully oriented to satisfy urban demands. Crop production is practiced on 77,000 ha in winter season. About 54% of this area is in urban part of the state. Major crop production in the urban area comes from large private and cooperative schemes and the biggest share of the cultivated area was allotted to fodder crops (55%), followed by vegetables (27.4%), fruits (6.4%), field crops (3.2) and spices (1.3%). (Policy Assessment, Consultancy & Training (PACT) 2010)

3.6 Population and their activities:

According to 2008 population census, the population of Khartoum state is estimated to be about eight million people who are a mixture of tribes of the Sudan. If we want to define the tribes living in Khartoum state in some details and specificity, we find that the peripheries of the cities and rural areas inhabited by distinguished: in the areas of Omdurman and the rural South, we find the tribe of Gamowia as we find the Kordofani tribes displaced to these areas as the drought and desertification that hit their areas in the past years (early and mid-eighties) where you will find in these areas tribes of Kababish and the Kawahla. In the northern countryside of Karari province, we find the tribe of Shiheinat, in Khartoum North there are the tribes of Abdallab and Batahin. In the East Nile, there are the tribes of Abu Dileig, Batahin, and Kawahla with the tribe of Iseilat in Um-Dowan. As to the activity of the population of Khartoum state, it can be said that most of the population are workers and personnel in the State chambers, the private sector and banks. Also, there is a large segment of capitalists dealing in trade and another segment represented by migrants and displaced people working in marginal activities. As to countrymen, they are engaged in agriculture, grazing and thus supply the capital, Khartoum, with vegetables, fruits, dairy. there are also some residents who live on the banks of the river engaged in the river-related works such as pottery, brick and fishing. http://www.krt.gov.sd/khartoumen.php 2013

3.7 Socio- Economic Framework of the State

Khartoum State is characterized as the most economically active center of the country, by virtue of its status as the political capital of Sudan. The population is engaged in the different sectors of the economy. A considerable number of the populations are workers and staff in the offices of the State and the private sector and banks. A large segment of capital owners works in trade. Other segment represented by the migrants and displaced is working in marginal businesses. The rural population serves in agriculture and grazing and supply Khartoum State with vegetables, fruits and dairy products. There are also some residents who live on the river banks and are engaged in manufacturing pottery and bricks and fishing.

The northern part of Khartoum State (Bahri) is characterized by its several and diverse economic activities. However, agriculture and industry build the back bone of the activities. For instance, Bahri is the major industrial region of Sudan, having the oil refinery and the vast lands suitable for agriculture and animal husbandry that have not yet been utilized. Khartoum State is also the center of attraction for the presence of industries and services, employment opportunities, resulting in the provision of basic services, such as, health care, education, and social welfare. It is also characterized by the presence of infrastructure and urban expansion. Khartoum state is the political capital of the Sudan and there are offices of state and government institutions, ministries, and embassies, international and regional organizations. In Greater Omdurman area most of the economic activities concentrate on freelance

and private projects which represent 80% to the total size of the population operations. These include: Commercial works that are characterized by high revenue, likewise agriculture and small scale professions. (Policy Assessment, Consultancy & Training (PACT) 2010)

3.8 Background of project:

In Season 2008 -2009 Khartoum State launched the biggest experiment of wheat cultivation since several decades in an area estimated to be about 25,000 feddans. This report is preliminary review of the technical aspects of this experiment depending on data collected by the staff of the Ministry of Agriculture, Khartoum State (General Administration of Agricultural Extension). The data included total cultivated area, production, agricultural inputs and farming operations" (TTEA 2009).

3.9 Area Production and Productivity:

Table (3-1) show area, production and productivity of wheat in the scheme and sector in Khartoum State season (2008 -2009).

The total area was about 24.495 feddans. Sundus scheme alone has 19.611 feddans of this area. The general average of wheat productivity at the level of the State was about 4 sacks/feddan ranging between Zero - 6 sacks/feddan. The general average of wheat production in Sundus scheme was about 4.8 sacks/feddan. The highest average & productivity at the level of the schemes amounted 6 sacks/feddan recorded by Abu Halima –Elkadaro cooperative society, whereas the lowest average of production (Zero < 1 sack/feddan) was recorded by Elshfeab, Wad Hadu, El-Seyal South

cooperatives in addition to Elisailat scheme. The high coefficient of difference of average productivity (62 %) indicates great variability in production conditions at the different locations. (TTEA 2009).

Table 3-1 Area, production and productivity of wheat in the schemes and the sector (Khartoum State 2008 -2009):

Scheme	Area		Production		Productivity	
	Feddan	(%)	Sack	(%)	sacks	Feddan
Sundus	19.611	80.1	90765	86.7	4.81	
El Silait N	712	2.91	2887	2.8	3.50	
El Silait S	152	0.62	469	0.45	3.95	
El Jummuia	1044	4.26	3244	3.1	2.77	
El Isailat	640	2.61	156	0.15	0.22	
Wad Ramli coo.	435	1.78	1979	1.9	4.29	
El Khojalab coo.	279	1.14	1100	1.1	4.07	
Dabak and Eltikaina coo.	300	1.22	1100	1.1	3.67	
Wad Hadu coo.	438	1.79	30	0.02	0.39	
El Sururab coo.	175	0.71	556	0.63	3.85	
El-Seyal. S. Coo.	170	0.69	162	0.15	0.95	
Abu Halima –Elkadaro coo.	120	0.49	737	0.70	6.14	
El Nya coo.	54	0.22	332	0.32	5.84	
El shfeab coo.	50	0.20	Zero	Zero	Zero	
Elulujab coo.	20	0.09	23	0.01	1.15	
El Doam coo.	10	0.05	28	0.01	2.80	
Private schemes	285	1.16	904	0.92	4.62	
Total	24495		104633			

State average productivity (0.15±) 3.96 CV (%) 62.2

Sector	Area		Production		Productivity	
	Feddan	(%)	sack	(%)	sacks	Feddan
Schemes	22158	90.1	97521	93.2	3.96	
Cooperatives	2052	8.38	6148	5.88	3.90	
Private schemes	285	1.16	964	0.92	4.62	

3.10 Implementation Level of Different Farming Operations:

Table (3-2) show implementation level of farming operations at the different production sites Generally speaking wheat cultivation dates were characterized by delay. In most sites the average cultivation delay from mid November on the level of the state was about 31 days varying from 20 to 42 days. Average delay at Sundus scheme was 27 days. Varying from 11 to 52 days. The least average delay (16 days) was recorded by Dabak and Eltikaina cooperatives while the longest average delay of cultivation from mid November (62 days) was reported at Elshfeab cooperative. (TTEA 2009)

The general average of the number of waterings on the level of the state was 6.8 watering varying from 5 watering (Elisailat and Elshfeab) to 8 watering (Dabak, Eltikaina, Elsyal and Elulujab). The average of the number of watering in Sundus scheme amounted to 6.6 watering. As for fertilization situation (full dose 6-$^{+}$) the average on the level of the state amounted to 4.98 ◌ً varying from zero (Elshfeab cooperative society) to 6 ◌ًin a number of schemes. The fertilizer dose in Sundus scheme was 4◌ً.5 whereas it was low in Elisailab (2◌ً.5) and El Jummuia 3◌ً.3). (TTEA 2009)

Table 3-2 Level of Implementation of Wheat Farming Operations in the Schemes (Khartoum State (2008 -2009)

Project	Delay of sowing from 14 Nov.			Fertilizer dose +
	Average	Variation		
Sundus	26.6	(11.52)	6.6	4.5
El Silait N	23.1	(7.44)	7	5.1
El Silait S	23.5	(6.47)	7.2	5.5
El Jummuia	21	(6.53)	7.3	3.3
Elisailat	41	(41.41)	5	2.5
Wad Ramli coo.	30	(15.32)	7.1	6
Elkhojalab coo.	26.3	(10.41)	6.4	6
Dabak and Eltikaina coo.	16	(16.16)	8	6
Wad Hadu coo.	37.5	(26.49)	7	5
El Sururab coo.	43.8	(21.69)	5.5	6
El-Seyal. S. Coo.	32	(32.32)	8	6
Abu Halima – Elkadaro coo.	47	(47.57)	7	6
El-Nya coo.	22	(15.25)	6.8	6
Elshefeab coo.	62	(62.62)	5	Zero
Elulujab coo.	54	(17.31)	8	6
El Doam coo.	27	(21.34)	6.5	6
Private schemes	26.8	(18.34)	7.8	8.4
Average	**31**	**(20.42)**	**6.84**	**4.98**

+ full dose = 6 ُ(2 sack Urea + 1 sack super phosphate per feddan)

3.11 Varieties:

Table 3-5 shows the cultivated area and productivity of each Variety on the level of the state while table 3-3 reviews the productivity of each variety in each scheme Imam variety was cultivated in an area of 18.720 feddans covering about 77 % of the total area, followed by Nabta Variety (3599 feddans) which was cultivated in all production sites excluding Sundus, Seliat South and El Sayal. The highest productivity was obtained by El Nelein and Argin varieties where their general average productivity per feddan was 5.33 and 5.64 sacks/feddan respectively. In Sundus scheme the productivity of El Nelein (7.16 sacks/feddan) was higher than that of Argin (5.59 sacks/feddan) while the opposite is true in El Jummuia scheme where Imam variety has recorded a general average of (4.5 sacks/feddan). The lowest productivity was recorded by Nabta variety with a general average of (2.85 sacks/feddan) followed by Sasaraib variety which recorded a general average of (3.17sacks/feddan). (TTEA 2009)

Table 3-3 Area and productivity of wheat Varieties (Khartoum State 2008 - 2009)

	Productivity Per feddan				
Variety	Feddans	(%)	sack	SE±	CV (%)
Imam	18720	76.6	4.50	0.16	58.5
Nabta	3599	14.7	2.85	0.15	75.8
El Nilain	1069	4.4	5.33	0.46	52
Argin	665	2.7	5.64	0.69	40.6
Sasaraib	379	1.6	3.17	1.04	82.3

Average: 4.3 S.e.d = 0.78

3-12 The conceptual model of the study

The conceptual model (Figure 3.1), which employed in this study, was developed as a framework for causal explanation of the impact of the extension programs on adoption of wheat production in Khartoum State in season 2008/2009. The model is focused on 10 variables, which are arranged in a logical casual order to provide the explanation of the of the extension programs on adoption of wheat production in Khartoum State, and its determining significant factors. Are namely participation in project development activities, adoption of improved wheat production technology, gross income from wheat production, total farmland area in possession, total production of wheat in sacks, total amount of finance received, access to agricultural extension services, age, and formal education and family size.

Besides the conceptual model variables, the analysis for evaluation of the impact of extension programs on adoption of improved wheat production technology in Khartoum state introduced comparative analysis relating to some other variables not included in the casual model of the study. These include participation in training extension program.

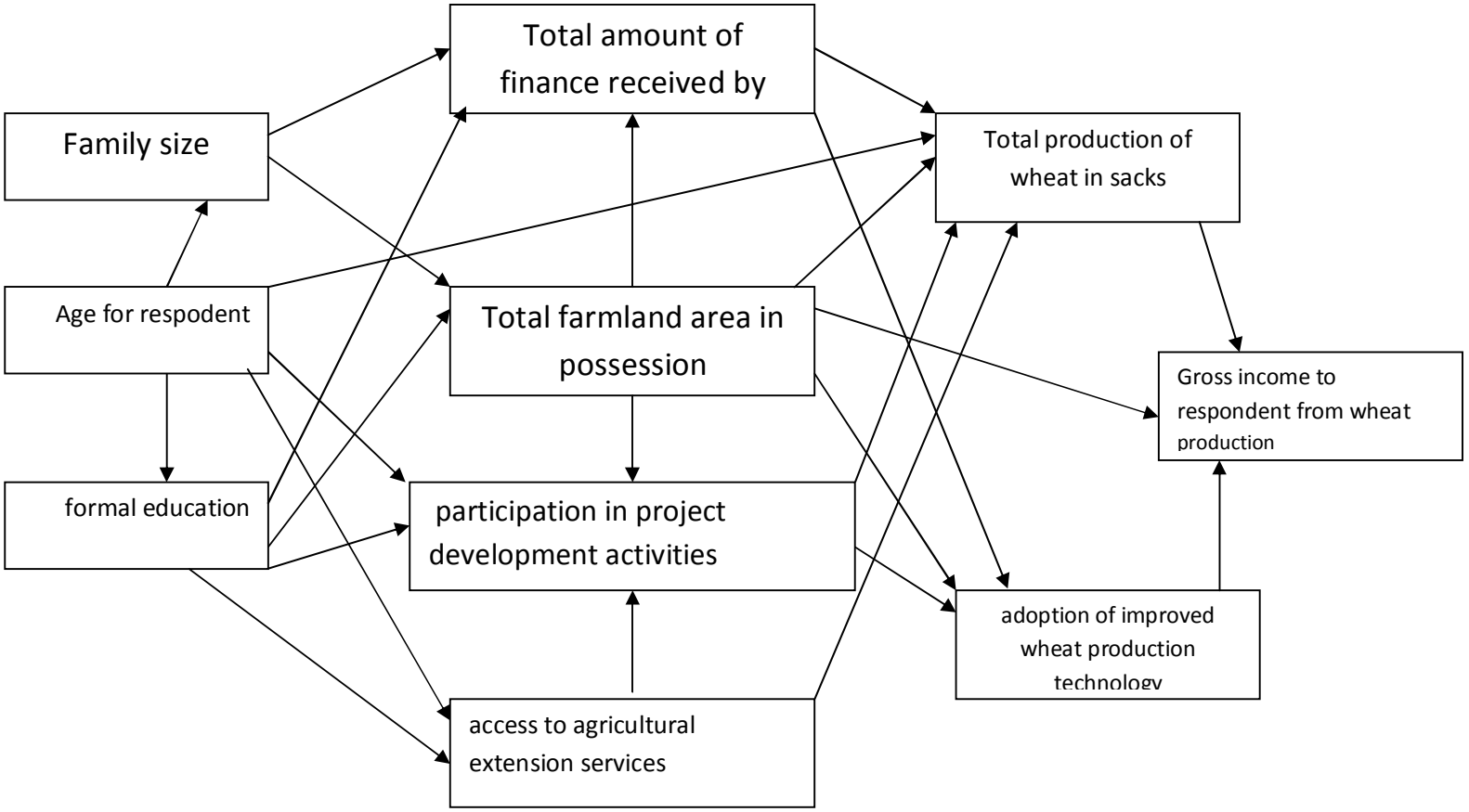

Figure 3-1 Conceptual Frame work

3-13 The hypotheses

The hypotheses of this study are following: -

1- Gross income to respondent from wheat production is affected significantly and positively by adoption of improved wheat production technology, total production of wheat in sacks and total farmland area in possession.

2- Total production of wheat in sacks is affected significantly and positively by participation in project development activities, total amount of finance received by respondent, total farmland area in possession, access to agricultural extension services and negative in age

3- Adoption of improved wheat production technology is affected significantly and positively by participation in project development activities, total farmland area in possession and total amount of finance received by respondent.

4- Participation in project development activities is affected significantly and positively by access to agricultural extension services, formal education, total farmland area in possession and age.

5- Access to agricultural extension services is affected significantly and positively by formal education and age.

6- Total amount of finance received by respondent is affected significantly and positively by total farmland area in possession, formal education and negative in family size.

7- Total farmland area in possession is affected significantly and positively by formal education and family size.

3.14 Population of the study

The population of the study is presented by the all farmers in 17 projects which were chosen by the General Administration of Agricultural Extension in season 2008/2009. Namely: Sundus, El Silait N, El Silait S, El Jummuia, El Isailat, Wad Ramli, El Khojalab, Dabak and Eltikaina, Wad Hadu, El Sururab, El Seyal, Abu Halima –Elkadaro, El Nya, El shfeab, Elulujab, El Doam, and Private schemes.

3-15 Sample selection procedures and sample size

This study is intended to cover the impact of the extension programs on adoption of wheat production in Khartoum State. Stratified random sampling method was used to select one hundred and fifty respondents of the total eight hundred eighty-five members of the population in seven projects namely: El Jummuia, El Isailat, Wad Ramli, El Khojalab, Dabak and Eltikaina, El Sururab and Abdalla Kadamour. The table blow detailing sample selection procedure number of projects and respondents from each project.

Table 3-4 **sample selection procedure:**

Project	**Number of farmers**	**Sample size**
El Sururab	146	25
El Khojalab	36	6
Dabak & El Tikaina	248	42
Abdalla Kadamour	51	9
El Jummuia	247	41
Wad Ramli	124	21
El Isailat	33	6
Total	**885**	**150**

Source: Projects management offices in Khartoum State.

3-16 Data collection procedure

The primary data of the study were collected through individual interviews, using of structured questionnaires (see appendix) supported by observation.

3-17 Data analysis procedures

Different statistical procedures were used in this study for purposes of descriptive analysis, including T-test procedure, correlation analysis (to identify significant correlates of the model variables), and regression analysis (for testing the postulated causal model of the impact of the extension programs on adoption of wheat production in Khartoum State). Regression analysis constituted the principal procedure for extending casual explanation by means of the application of path analysis.

Chapter Four
RESULTS AND DISCUSSION

This chapter primarily intends present and interpret the results of data analysis. It intended first to present socio-economic background characteristics of the sample, and the results of the t-test analysis for determining the significance of the observed differences between seven projects, and then to show the results of correlation and enter multiple regression analysis for testing the study hypotheses and postulated causal model.

4.1 Socio- economic background characteristics of respondents and farm related aspects of the sample:

Table 4.1 shows statistics on mean score of selected variables obtained by respondents in the different wheat production projects under study. From the table, El Jammuia project had achieved the relatively highest scores on adoption of the components of wheat production technological package, total wheat production, amount of wheat sold and gross income from wheat, and ranked a second in agricultural finance and wheat productivity. Farmers in El Isailat had received the highest amounts of agricultural finance but produced lesser amounts of wheat (which was mainly consumed in the farmers' households). Astonishing also is the fact that the area under wheat in El Isailat was the highest, and the average score on farmer education was also the highest; but the score on adoption of the recommended wheat

production technology and wheat productivity were the least in El Isailat. That means wheat production was a failure in the projects where farmers are less committed.

Table 4.1: Mean Farmers' Scores on Research Variables by Project

Variables	El Sururab	El Khojalab	Dabak and El tikaina	Abdalla Kadamoor	El Jammuia.	Wad Ramli	El Isailat
Farmer education	6.32	10.17	5.64	2.89	6.78	10.67	12.67
Family size	6.28	7.17	5.52	7.56	6.59	4.90	4.67
Family education	5.88	6.67	4.10	5.56	5.29	4.71	4.00
Family labour	.76	.83	.38	.33	.39	.57	.00
Family income	9658.00	36650.00	9663.81	9244.44	15580.24	9542.86	7600.00
Farmer income SDGs	5818.00	18850.00	6893.33	3444.44	12688.54	7371.43	5600.00
Farmland area	1.32	16.17	2.67	1.78	13.70	8.05	25.00
Wheat productivity/unit area	3.68	3.89	5.57	7.31	6.01	4.28	.95
Wheat area	1.32	3.67	1.93	1.56	6.99	4.83	25.00
Wheat production (sacks)	4.48	13.67	10.56	10.67	42.85	25.30	20.00
Wheat consumption (sacks)	.00	1.17	1.31	.56	3.02	.96	6.67
Wheat sold (sacks)	4.48	14.17	9.25	10.11	40.07	23.16	13.33
Gross wheat income SDGs	70.40	218.33	221.43	44.44	1772.20	253.57	.00
Finance amount SDGs	580.20	1566.67	1004.76	966.67	2467.68	2434.76	10000.00
Adoption of wheat package	14.8400	15.8333	9.8810	11.5556	20.0732	17.3333	3.1667

4.1.1 Adoption of Wheat Production Technological Package

The respondents in El Jummuia project have the highest mean rate of adoption of components of the wheat production technological package, followed respectively by those in Wad Ramli, El Khojalab, El Sururab, Abdalla Kadamoor, and Dabak. Farmers in El Isailat received the least adoption score, and that may be explained by the fact that most of them do not practice farm work on their land. They lease out most of their land parcels for others to cultivate. These latter ones have no secure access to farm land and, thus, are not motivated to adopt high cost innovations.

4.1.2 Wheat Productivity

Farmers in Abdalla Kadamour project achieved the highest score on wheat productivity (7.31 sacks/feddan), followed by El Jammuia (6.01 sacks per feddan). Wad Ramli ranked the 3rd.

4.1.3 Formal education

The ranged between 2.89 and 12,67 years, The highest score on mean years of education was achieved by farmers in El Isailat, but it seems that the impact of their relatively high level of education on adoption behavior was not positive.

4.1.4 Family variables

The highest scores on family education, family size, family labour, family income and farmer income were obtained by farmers in El Khojalab. These variables seem to have a positive impact on agricultural finance and adoption of the recommended wheat production package. The highest amount of consumed wheat was found in El Isailat (6.67 sacks), and the lowest amount of wheat consumed (none) was in El Sururab.

4.1.5 Amount of wheat sold (in sacks)

Highest amount of wheat sold was found in El Jummuia (40.07 sacks), and the least amount of wheat sold was in El Sururab (4.48 sacks).

4.1.6 Gross income from wheat

The highest gross income from wheat production was found in El Jammuia (1772.20 SDGs per farmer), and the least gross income from wheat production was found El Isailat where farmers did not sell their produce and used it for household consumption.

4.1.7 Total amount of finance received by respondent

The highest amount of finance received by individual farmers was in El Isailat (10000.00), and the least amount of finance was El Sururab 580.20.

4.2 Comparison of wheat productivity and total production in the seven projects:

4.2.1 Mean wheat production

From Table 4.2, we find that the highest mean production of wheat per farmer was achieved in El Jummuia project (42.85 sacks), followed by Wad Ramli (25.30 sacks), and the least wheat production was in El Sururab 4.48.

Table 4.2: Descriptive statistics on wheat productivity and related variables in the seven projects

Projects	Mean wheat productivity (sacks/feddan)			Mean area under wheat (Feddan)	Mean total production of wheat (Sacks)
	Minimum	Mean	Maximum		
El Sururab	1.0	3.68	10.0	1.32	4.48
El Khojalab	0.6	3.89	8.75	3.67	13.67
Dabak & El Tikaina	0.0	5.53	15.00	1.93	10.56
Abdalla Kadamour	3.0	7.31	12.00	1.56	10.67
El Jummuia	0.45	6.01	15.00	6.99	42.85
Wad Ramli	0.0	4.28	15.00	4.83	25.30
El Isailat	0.0	0.95	5.00	25.00	20.0

4.2.2 Area under wheat

The largest area cultivated is found in El Jummuia project (6.99 feddan), followed by Wad Ramli (4.83 feddan), and the least wheat area per farmer was in El Sururab (1.32 feddan).

4.2.3 Wheat productivity (sacks/feddan)

We find the highest mean wheat productivity in Abdalla Kadamour (7.31 sacks per feddan), followed by El Jummuia (6.01 sacks per feddan), and the least productivity was in El Isailat (0.95 sacks per feddan).

This study revealed that El Jummuia project has succeeded to achieve greater level of adoption of the recommended technological package for wheat production. This is attribute to high level of access to extension services, and the long wheat production experience of most of the participating farmers

4.3 t-test analysis results

t-test analysis results for identifying the significant differences between the 7 wheat production projects under study in relation to the study variables.

4-3-1 Comparison between pairs of projects in terms of the Significance of differences in the magnitude of selected variables years

4.3.1.1 Sururab and Khojalab

From Table 4.3 and the detailed results of t-test analysis, there are significant differences between *Sururab* and *Khojalab* projects in terms of:

1. Farmers' family income (mean scores being 9658.00 and 36650.00 respectively),
2. Farmer income (mean scores being 5818.00 and 18850.00 respectively),
3. Land area (mean scores being 1.32 and 16.17 respectively),
4. Wheat area (mean scores being 1.32 and 3.67 respectively),
5. Wheat production (mean scores being 4.48 and 13.67 respectively),
6. Wheat consumption (mean scores being .00 and 1.17 respectively),
7. Wheat sold (mean scores being 4.48 and 14.17 respectively), and
8. Wheat finance amount (mean scores being 580.20 and 1566.67 respectively).

Table 4-3: t-test Analysis for El Sururab and El Khojalab Projects

Variables	Name of project	Mean	Mean difference	t	Sig.
Formal education	El Sururab	6.32	-3.847	-1.710	.098
	El Khojalab	10.17			
Family size	El Sururab	6.28	-.887	-.816	.421
	El Khojalab	7.17			
Family Education	El Sururab	5.88	-.787	-.702	.488
	El Khojalab	6.67			
Family farm labours	El Sururab	.76	-.073	-.150	.882
	El Khojalab	.83			
Family income	El Sururab	9658.00	-26992.000	-4.339	.000
	El Khojalab	36650.00			
Farmer income	El Sururab	5818.00	-13032.000	-5.115	.000
	El Khojalab	18850.00			
Land area	El Sururab	1.32	-14.847	-4.430	.000
	El Khojalab	16.17			
Wheat area	El Sururab	1.32	-2.347	-4.154	.000
	El Khojalab	3.67			
Wheat production	El Sururab	4.48	-9.187	-3.264	.003
	El Khojalab	13.67			
Wheat consumed	El Sururab	.00	-1.167	-2.574	.015
	El Khojalab	1.17			
Wheat sold	El Sururab	4.48	-9.687	-3.793	.001
	El Khojalab	14.17			
Gross income wheat	El Sururab	70.40	-147.933	-1.366	.182
	El Khojalab	218.33			
Total amount of finance received by respondent	El Sururab	580.20	-986.467	-4.208	.000
	El Khojalab	1566.67			
Adoption of wheat production Technological	El Sururab	14.8400	-.99333	-1.164	.254
	El Khojalab	15.8333			

4.3.1.2 Sururab and Dabak and El tikaina

From Table 4.4 and the detailed results of t-test analysis, there are significant differences between *Sururab* and *Dabak and El tikaina* projects in terms of:

1. Family education (mean scores being 5.88 and 4.10 respectively),
2. Land area (mean scores being 1.32 and 2.67 respectively),
3. Wheat production (mean scores being 4.48 and 10.56 respectively),
4. Wheat consumption (mean scores being .00 and 1.31 respectively),
5. Wheat sold (mean scores being 4.48 and 9.25 respectively),
6. Wheat finance amount (mean scores being 580.20 and 1004.76 respectively), and
7. Adoption of wheat production technological package (mean scores being 14.8400 and 9.8810 respectively).

4.3.1.3 Sururab and Abdalla Kadamoor

From Table 4.5 and the detailed results of t-test analysis, there are significant differences between *Sururab* and *Abdalla Kadamoor* projects in terms of:

1. Farmer income (mean scores being 5818.00 and 3444.44 respectively),
2. Wheat production (mean scores being 4.48 and 10.67 respectively),
3. Wheat sold (mean scores being 4.48 and 10.11 respectively),
4. Wheat finance amount (mean scores being 580.20 and 966.67 respectively), and
5. Adoption of wheat production technological package (mean scores being 14.8400 and 11.5556 respectively).

Table 4-4: t-test Analysis for El Sururab and Dabak and El tikaina Projects

Variables	name of project	Mean	Mean Difference	T	Sig.
Formal education	El Sururab	6.32	.677	.508	.613
	Dabak and El tikaina	5.64			
Family size	El Sururab	6.28	.756	1.043	.301
	Dabak and El tikaina	5.52			
Family Education	El Sururab	5.88	1.785	2.819	.006
	Dabak and El tikaina	4.10			
Family farm labours	El Sururab	.76	.379	1.639	.106
	Dabak and El tikaina	.38			
Family income	El Sururab	9658.00	-5.810	-.003	.997
	Dabak and El tikaina	9663.81			
Farmer income	El Sururab	5818.00	-1075.333	-.856	.395
	Dabak and El tikaina	6893.33			
Land area	El Sururab	1.32	-1.351	-3.286	.002
	Dabak and El tikaina	2.67			
Wheat area	El Sururab	1.32	-.607	-1.651	.104
	Dabak and El tikaina	1.93			
Wheat production	El Sururab	4.48	-6.080	-2.339	.022
	Dabak and El tikaina	10.56			
Wheat consumed	El Sururab	.00	-1.310	-1.990	.051
	Dabak and El tikaina	1.31			
Wheat sold	El Sururab	4.48	-4.770	-2.259	.027
	Dabak and El tikaina	9.25			
gross income wheat	El Sururab	70.40	-151.029	-1.032	.306
	Dabak and El tikaina	221.43			
Total amount of finance received by respondent	El Sururab	580.20	-424.562	-3.185	.002
	Dabak and El tikaina	1004.76			
Adoption of wheat production Technological	El Sururab	14.8400	4.95905	7.334	.000
	Dabak and El tikaina	9.8810			

Table 4-5: t-test Analysis for El Sururab and Abdalla Kadamoor Projects.

Variables	name of project	Mean	Mean Difference	t	Sig.
Formal education	El Sururab	6.32	3.431	1.889	.068
	Abdalla Kadamoor	2.89			
Family size	El Sururab	6.28	-1.276	-1.248	.221
	Abdalla Kadamoor	7.56			
Family Education	El Sururab	5.88	.324	.361	.720
	Abdalla Kadamoor	5.56			
Family farm labours	El Sururab	.76	.427	1.088	.285
	Abdalla Kadamoor	.33			
Family income	El Sururab	9658.00	413.556	.166	.869
	Abdalla Kadamoor	9244.44			
Farmer income	El Sururab	5818.00	2373.556	2.149	.039
	Abdalla Kadamoor	3444.44			
Land area	El Sururab	1.32	-.458	-1.160	.255
	Abdalla Kadamoor	1.78			
Wheat area	El Sururab	1.32	-.236	-.586	.562
	Abdalla Kadamoor	1.56			
Wheat production	El Sururab	4.48	-6.187	-3.706	.001
	Abdalla Kadamoor	10.67			
Wheat consumed	El Sururab	.00	-.556	-1.715	.096
	Abdalla Kadamoor	.56			
Wheat sold	El Sururab	4.48	-5.631	-3.632	.001
	Abdalla Kadamoor	10.11			
Gross income wheat	El Sururab	70.40	25.956	.479	.635
	Abdalla Kadamoor	44.44			
Total amount of finance received by respondent	El Sururab	580.20	-386.467	-6.065	.000
	Abdalla Kadamoor	966.67			
Adoption of wheat production Technological	El Sururab	14.8400	3.28444	3.807	.001
	Abdalla Kadamoor	11.5556			

4.3.1.4 Sururab and El Jummuia

From Table 4.6 and the detailed results of t-test analysis, there are significant differences between *Sururab* and *El Jummuia* projects in terms of:

1. Farmers' family income (mean scores being 9658.00 and 15580.24 respectively),
2. Farmer income (mean scores being 5818.00 and 12688.54 respectively),
3. Land area (mean scores being 1.32 and 13.70 respectively),
4. Wheat area (mean scores being 1.312 and 6.99 respectively),
5. Wheat production (mean scores being 4.48 and 42.85 respectively),
6. Wheat consumption (mean scores being .00 and 3.02 respectively),
7. Wheat sold (mean scores being 4.48 and 40.07 respectively),
8. Wheat gross income (mean scores being 70.40 and 1772.20 respectively),
9. Wheat finance amount (mean scores being 580.20 and 2467.68 respectively), and
10. Adoption of wheat production technological package (mean scores being 14.8400 and 20.0732 respectively).

Table 4-6: t-test Analysis for El Sururab and El Jummuia Projects

Variables	name of project	Mean	Mean Difference	T	Sig.
Formal education	El Sururab	6.32	-.460	-.368	.714
	El Jummuia	6.78			
family size	El Sururab	6.28	-.305	-.444	.659
	El Jummuia	6.59			
Family Education	El Sururab	5.88	.587	1.014	.314
	El Jummuia	5.29			
family farm labours	El Sururab	.76	.370	1.792	.078
	El Jummuia	.39			
Family income	El Sururab	9658.00	-5922.244	-2.268	.027
	El Jummuia	15580.24			
Farmer income	El Sururab	5818.00	-6870.537	-2.857	.006
	El Jummuia	12688.54			
Land area	El Sururab	1.32	-12.380	-4.533	.000
	El Jummuia	13.70			
Wheat area	El Sururab	1.32	-5.665	-3.559	.001
	El Jummuia	6.99			
Wheat production	El Sururab	4.48	-38.374	-3.344	.001
	El Jummuia	42.85			
Wheat consumed	El Sururab	.00	-3.024	-3.864	.000
	El Jummuia	3.02			
Wheat sold	El Sururab	4.48	-35.593	-3.292	.002
	El Jummuia	40.07			
gross income wheat	El Sururab	70.40	-1701.795	-2.901	.005
	El Jummuia	1772.20			
Total amount of finance received by respondent	El Sururab	580.20	-1887.483	-3.940	.000
	El Jummuia	2467.68			
Adoption of wheat production Technological	El Sururab	14.8400	-5.23317	-4.629	.000
	El Jummuia	20.0732			

4.3.1.5 Sururab and Wad Ramli

From Table 4.7 and the detailed results of t-test analysis, there are significant differences between *Sururab* and *Wad Ramli* projects in terms of:

1. Formal education (mean scores being 6.32 and 10.67 respectively),
2. Land area (mean scores being 1.32 and 8.05 respectively),
3. Wheat area (mean scores being 1.32 and 4.83 respectively),
4. Wheat consumption (mean scores being .00 and .96 respectively),
5. Wheat finance amount (mean scores being 580.20 and 2434.76 respectively), and
6. Adoption of wheat production technological package (mean scores being 14.8400 and 17.3333 respectively).

Table 4-7: t-test Analysis for El Sururab and Wad Ramli Projects

Variables	name of project	Mean	Mean Difference	T	Sig.
Formal education	El Sururab	6.32	-4.347	-3.276	.002
	Wad Ramli	10.67			
Family size	El Sururab	6.28	1.375	1.894	.065
	Wad Ramli	4.90			
Family Education	El Sururab	5.88	1.166	1.727	.091
	Wad Ramli	4.71			
Family farm labours	El Sururab	.76	.189	.625	.535
	Wad Ramli	.57			
Family income	El Sururab	9658.00	115.143	.054	.957
	Wad Ramli	9542.86			
Farmer income	El Sururab	5818.00	-1553.429	-.929	.358
	Wad Ramli	7371.43			
Land area	El Sururab	1.32	-6.728	-2.117	.040
	Wad Ramli	8.05			
Wheat area	El Sururab	1.32	-3.506	-2.366	.022
	Wad Ramli	4.83			
Wheat production	El Sururab	4.48	-20.818	-1.594	.118
	Wad Ramli	25.30			
Wheat consumed	El Sururab	.00	-.964	-2.470	.017
	Wad Ramli	.96			
Wheat sold	El Sururab	4.48	-18.677	-1.448	.155
	Wad Ramli	23.16			
gross income wheat	El Sururab	70.40	-183.171	-1.788	.081
	Wad Ramli	253.57			
Total amount of finance received by respondent	El Sururab	580.20	-1854.562	-2.823	.007
	Wad Ramli	2434.76			
Adoption of wheat production Technological	El Sururab	14.8400	-2.49333	-2.720	.009
	Wad Ramli	17.3333			

4.3.1.6 Sururab and El Isailat

From Table 4.8 and the detailed results of t-test analysis located in Appendix 1, there are significant differences between *Sururab* and *El Isailat* projects in terms of:

1. Formal education (mean scores being 6.32 and 12.67 respectively),
2. Land area (mean scores being 1.32 and 25.00 respectively),
3. Wheat area (mean scores being 1.32 and 25.00 respectively),
4. Wheat production (mean scores being 4.48 and 20.00 respectively),
5. Wheat consumption (mean scores being .00 and 6.67 respectively),
6. Wheat sold (mean scores being 4.48 and 13.33 respectively),
7. Wheat finance amount (mean scores being 580.20 and 10000.00 respectively), and
8. Adoption of wheat production technological package (mean scores being 14.8400 and 3.1667 respectively).

Table 4-8: t-test Analysis for El Sururab and El Isailat Projects

Variables	Name of project	Mean	Mean Difference	t	Sig.
Formal education	El Sururab	6.32	-6.347	-3.360	.002
	El Isailat	12.67			
family size	El Sururab	6.28	1.613	1.415	.168
	El Isailat	4.67			
Family Education	El Sururab	5.88	1.880	1.839	.076
	El Isailat	4.00			
family farm labours	El Sururab	.76	.760	1.629	.114
	El Isailat	.00			
Family income	El Sururab	9658.00	2058.000	.801	.429
	El Isailat	7600.00			
Farmer income	El Sururab	5818.00	218.000	.169	.867
	El Isailat	5600.00			
Land area	El Sururab	1.32	-23.680	-3.407	.002
	El Isailat	25.00			
Wheat area	El Sururab	1.32	-23.680	-3.407	.002
	El Isailat	25.00			
Wheat production	El Sururab	4.48	-15.520	-2.535	.017
	El Isailat	20.00			
Wheat consumed	El Sururab	.00	-6.667	-3.420	.002
	El Isailat	6.67			
Wheat sold	El Sururab	4.48	-8.853	-2.059	.049
	El Isailat	13.33			
gross income wheat	El Sururab	70.40	70.400	1.205	.238
	El Isailat	.00			
Total amount of finance received by respondent	El Sururab	580.20	-9419.800	-146.534	.000
	El Isailat	10000.00			
Adoption of wheat production Technological	El Sururab	14.8400	11.67333	9.235	.000
	El Isailat	3.1667			

4.3.1.7 El Khojalab and Dabak and El tikaina

From Table 4.9 and the detailed results of t-test analysis, there are significant differences between *El Khojalab* and *Dabak and El tikaina* projects in terms of:

1. Farmers' family income (mean scores being 36650.00 and 9663.81 respectively),
2. Farmer income (mean scores being 18850.00 and 6893.33 respectively), and
3. Land area (mean scores being 16.17 and 2.67 respectively).

4.3.1.8 El Khojalab and Abdalla Kadamoor

From Table 4.10 and the detailed results of t-test analysis, there are significant differences between *El Khojalab* and *Abdalla Kadamoor* projects in terms of:

1. Farmers' family income (mean scores being 36650.00 and 9244.44 respectively),
2. Farmer income (mean scores being 18850.00 and 3444.44 respectively),
3. Land area (mean scores being 16.17 and 1.78 respectively),
4. Wheat area (mean scores being 3.67 and 1.56 respectively),
5. Wheat production (mean scores being 13.67 and 10.67 respectively),
6. Wheat gross income (mean scores being 218.33 and 44.44 respectively), and
7. Wheat finance amount (mean scores being 1566.67 and 966.67 respectively).

Table 4-9: t-test Analysis for El Khojalab project and Dabak and El tikaina projects.

Variables	name of project	Mean	Mean Difference	T	Sig.
Formal education	El Khojalab	10.17	4.524	1.782	.530
	Dabak and El tikaina	5.64			
Family size	El Khojalab	7.17	1.643	1.218	.425
	Dabak and El tikaina	5.52			
Family Education	El Khojalab	6.67	2.571	2.086	.830
	Dabak and El tikaina	4.10			
family farm labours	El Khojalab	.83	.452	1.360	.960
	Dabak and El tikaina	.38			
Family income	El Khojalab	36650.00	26986.190	5.026	.000
	Dabak and El tikaina	9663.81			
Farmer income	El Khojalab	18850.00	11956.667	4.049	.020
	Dabak and El tikaina	6893.33			
Land area	El Khojalab	16.17	13.495	5.102	.000
	Dabak and El tikaina	2.67			
Wheat area	El Khojalab	3.67	1.739	2.429	.353
	Dabak and El tikaina	1.93			
Wheat production	El Khojalab	13.67	3.107	.558	.468
	Dabak and El tikaina	10.56			
Wheat consumed	El Khojalab	1.17	-.143	-.102	.667
	Dabak and El tikaina	1.31			
Wheat sold	El Khojalab	14.17	4.917	1.087	.545
	Dabak and El tikaina	9.25			
gross income wheat	El Khojalab	218.33	-3.095	-.010	.801
	Dabak and El tikaina	221.43			
Total amount of finance received by respondent	El Khojalab	1566.67	561.905	1.759	.081
	Dabak and El tikaina	1004.76			
Adoption of wheat production Technological	El Khojalab	15.8333	5.95238	4.618	.212
	Dabak and El tikaina	9.8810			

Table 4-10: t-test Analysis for El Khojalab project and Abdalla Kadamoor projects.

Variables	name of project	Mean	Mean Difference	t	Sig.
Formal education	El Khojalab	10.17	7.278	2.358	.400
	Abdalla Kadamoor	2.89			
family size	El Khojalab	7.17	-.389	-.238	.639
	Abdalla Kadamoor	7.56			
Family Education	El Khojalab	6.67	1.111	.668	.799
	Abdalla Kadamoor	5.56			
family farm labours	El Khojalab	.83	.500	1.556	.501
	Abdalla Kadamoor	.33			
Family income	El Khojalab	36650.00	27405.556	2.626	.003
	Abdalla Kadamoor	9244.44			
Farmer income	El Khojalab	18850.00	15405.556	3.829	.009
	Abdalla Kadamoor	3444.44			
Land area	El Khojalab	16.17	14.389	2.500	.011
	Abdalla Kadamoor	1.78			
Wheat area	El Khojalab	3.67	2.111	3.225	.015
	Abdalla Kadamoor	1.56			
Wheat production	El Khojalab	13.67	3.000	.597	.044
	Abdalla Kadamoor	10.67			
Wheat consumed	El Khojalab	1.17	.611	.585	.424
	Abdalla Kadamoor	.56			
Wheat sold	El Khojalab	14.17	4.056	.923	.181
	Abdalla Kadamoor	10.11			
Gross income wheat	El Khojalab	218.33	173.889	1.040	.049
	Abdalla Kadamoor	44.44			
Total amount of finance received by respondent	El Khojalab	1566.67	600.000	1.508	.021
	Abdalla Kadamoor	966.67			
Adoption of wheat production Technological	El Khojalab	15.8333	4.27778	3.034	.421
	Abdalla Kadamoor	11.5556			

4.3.1.9 El Khojalab and El Jummuia

From Table 4.11 and the detailed results of t-test analysis, there are significant differences between *El Khojalab* and *El Jummuia* projects in terms of:

1. Farmers' family income (mean scores being 36650.00 and 155850.24 respectively).

4.3.1.10 El Khojalab and Wad Ramli

From Table 4.12 and the detailed results of t-test analysis, there are significant differences between *El Khojalab* and *Wad Ramli* projects in terms of:

1. Farmers' family income (mean scores being 36650.00 and 9542.86 respectively).

4.3.1.11 El Khojalab and El Isailat

From Table 4.13 and the detailed results of t-test analysis, there are significant differences between *El Khojalab* and *El Isailat* projects in terms of:

1. Formal Education (mean scores being 10.17 and 12.67 respectively),
2. Family labour (mean scores being .83 and .00 respectively),
3. Farmers' family income (mean scores being 36650.00 and 7600.00 respectively),
4. Farmer income (mean scores being 18850.00 and 5600.00 respectively),
5. Wheat area (mean scores being 3.67 and 25.00 respectively),
6. Wheat production (mean scores being 13.67 and 20.00 respectively),
7. Wheat consumption (mean scores being 1.17 and 6.67 respectively),
8. Wheat gross income (mean scores being 218.33 and .00 respectively), and
9. Wheat finance amount (mean scores being 1566.67 and 10000.00 respectively).

Table 4-11: t-test Analysis for El Khojalab project and El Jummuia projects.

Variables	name of project	Mean	Mean Difference	T	Sig.
Formal education	El Khojalab	10.17	3.386	1.439	.371
	El Jummuia	6.78			
Family size	El Khojalab	7.17	.581	.461	.546
	El Jummuia	6.59			
Family Education	El Khojalab	6.67	1.374	1.234	.399
	El Jummuia	5.29			
Family farm labours	El Khojalab	.83	.443	1.780	.574
	El Jummuia	.39			
Family income	El Khojalab	36650.00	21069.756	3.147	.000
	El Jummuia	15580.24			
Farmer income	El Khojalab	18850.00	6161.463	1.196	.707
	El Jummuia	12688.54			
Land area	El Khojalab	16.17	2.467	.401	.597
	El Jummuia	13.70			
Wheat area	El Khojalab	3.67	-3.319	-1.018	.140
	El Jummuia	6.99			
Wheat production	El Khojalab	13.67	-29.187	-1.235	.188
	El Jummuia	42.85			
Wheat consumed	El Khojalab	1.17	-1.858	-1.129	.347
	El Jummuia	3.02			
Wheat sold	El Khojalab	14.17	-25.907	-1.165	.149
	El Jummuia	40.07			
gross income wheat	El Khojalab	218.33	-1553.862	-1.288	.069
	El Jummuia	1772.20			
Total amount of finance received by respondent	El Khojalab	1566.67	-901.016	-.903	.319
	El Jummuia	2467.68			
Adoption of wheat production Technological	El Khojalab	15.8333	-4.23984	-1.874	.072
	El Jummuia	20.0732			

Table 4-12: t-test Analysis for El Khojalab project and El Wad Ramli projects.

Variables	name of project	Mean	Mean Difference	t	Sig.
Formal education	El Khojalab	10.17	-.500	-.215	.146
	Wad Ramli	10.67			
family size	El Khojalab	7.17	2.262	1.881	.737
	Wad Ramli	4.90			
Family Education	El Khojalab	6.67	1.952	1.540	.591
	Wad Ramli	4.71			
family farm labours	El Khojalab	.83	.262	.667	.495
	Wad Ramli	.57			
Family income	El Khojalab	36650.00	27107.143	3.752	.000
	Wad Ramli	9542.86			
Farmer income	El Khojalab	18850.00	11478.571	2.841	.191
	Wad Ramli	7371.43			
Land area	El Khojalab	16.17	8.119	1.081	.661
	Wad Ramli	8.05			
Wheat area	El Khojalab	3.67	-1.160	-.380	.144
	Wad Ramli	4.83			
Wheat production	El Khojalab	13.67	-11.631	-.428	.336
	Wad Ramli	25.30			
Wheat consumed	El Khojalab	1.17	.202	.213	.701
	Wad Ramli	.96			
Wheat sold	El Khojalab	14.17	-8.990	-.335	.294
	Wad Ramli	23.16			
gross income wheat	El Khojalab	218.33	-35.238	-.156	.919
	Wad Ramli	253.57			
Total amount of finance received by respondent	El Khojalab	1566.67	-868.095	-.627	.094
	Wad Ramli	2434.76			
Adoption of wheat production Technological	El Khojalab	15.8333	-1.50000	-.857	.464
	Wad Ramli	17.3333			

Table 4-13: t-test Analysis for El Khojalab project and El Isailat projects.

Variables	name of project	Mean	Mean Difference	T	Sig.
Formal education	El Khojalab	10.17	-2.500	-.869	.017
	El Isailat	12.67			
family size	El Khojalab	7.17	2.500	1.475	.386
	El Isailat	4.67			
Family Education	El Khojalab	6.67	2.667	1.423	.726
	El Isailat	4.00			
family farm labours	El Khojalab	.83	.833	2.712	.012
	El Isailat	.00			
Family income	El Khojalab	36650.00	29050.000	2.320	.006
	El Isailat	7600.00			
Farmer income	El Khojalab	18850.00	13250.000	2.681	.034
	El Isailat	5600.00			
Land area	El Khojalab	16.17	-8.833	-.531	.265
	El Isailat	25.00			
Wheat area	El Khojalab	3.67	-21.333	-1.421	.040
	El Isailat	25.00			
Wheat production	El Khojalab	13.67	-6.333	-.453	.015
	El Isailat	20.00			
Wheat consumed	El Khojalab	1.17	-5.500	-1.271	.001
	El Isailat	6.67			
Wheat sold	El Khojalab	14.17	.833	.083	.074
	El Isailat	13.33			
Gross income wheat	El Khojalab	218.33	218.333	1.107	.033
	El Isailat	.00			
Total amount of finance received by respondent	El Khojalab	1566.67	-8433.333	-17.295	.032
	El Isailat	10000.00			
Adoption of wheat production Technological	El Khojalab	15.8333	12.66667	5.491	.155
	El Isailat	3.1667			

4.3.1.12 Dabak and El tikaina and abdalla Kadamoor

From Table 4.14 and the detailed results of t-test analysis, there are significant differences between *Dabak and El tikaina and abdalla Kadamoor* projects in terms of:

1. Land area (mean scores being 2.67 and 1.78 respectively),
2. Wheat consumption (mean scores being 1.31 and .56 respectively),
3. Wheat gross income (mean scores being 221.43 and 44.44 respectively), and
4. Wheat finance amount (mean scores being 1004.76 and 966.67 respectively).

4.3.1.13 Dabak and El tikaina and El Jummuia

From Table 4.15 and the detailed results of t-test analysis located in Appendix 1, there are significant differences between *Dabak and El tikaina and El Jummuia* projects in terms of:

1. Farmers' family income (mean scores being 9663.81 and 15580.24 respectively),
2. Farmer income (mean scores being 6893.33 and 12688.54 respectively),
3. Land area (mean scores being 2.67 and 13.70 respectively),
4. Wheat area (mean scores being 1.93 and 6.99 respectively),
5. Wheat production (mean scores being 10.56 and 42.85 respectively),
6. Wheat sold (mean scores being 9.25 and 40.07 respectively),
7. Wheat gross income (mean scores being 221.43 and 1772.20 respectively),
8. Wheat finance amount (mean scores being 1004.76 and 2467.68 respectively), and
9. Adoption of wheat production technological package (mean scores being 9.8810 and 20.0732 respectively).

Table 4-14: t-test Analysis for Dabak and El tikaina project and Abdalla Kadamoor projects.

Variables	name of project	Mean	Mean Difference	T	Sig.
Formal education	Dabak and El tikaina	5.64	2.754	1.335	.705
	Abdalla Kadamoor	2.89			
Family size	Dabak and El tikaina	5.52	-2.032	-1.741	.854
	Abdalla Kadamoor	7.56			
Family Education	Dabak and El tikaina	4.10	-1.460	-1.463	.808
	Abdalla Kadamoor	5.56			
family farm labours	Dabak and El tikaina	.38	.048	.178	.581
	Abdalla Kadamoor	.33			
Family income	Dabak and El tikaina	9663.81	419.365	.150	.514
	Abdalla Kadamoor	9244.44			
Farmer income	Dabak and El tikaina	6893.33	3448.889	1.724	.068
	Abdalla Kadamoor	3444.44			
Land area	Dabak and El tikaina	2.67	.894	1.407	.058
	Abdalla Kadamoor	1.78			
Wheat area	Dabak and El tikaina	1.93	.372	.666	.508
	Abdalla Kadamoor	1.56			
Wheat production	Dabak and El tikaina	10.56	-.107	-.024	.558
	Abdalla Kadamoor	10.67			
Wheat consumed	Dabak and El tikaina	1.31	.754	.668	.001
	Abdalla Kadamoor	.56			
Wheat sold	Dabak and El tikaina	9.25	-.861	-.244	.074
	Abdalla Kadamoor	10.11			
gross income wheat	Dabak and El tikaina	221.43	176.984	.728	.033
	Abdalla Kadamoor	44.44			
Total amount of finance received by respondent	Dabak and El tikaina	1004.76	38.095	.172	.032
	Abdalla Kadamoor	966.67			
Adoption of wheat production Technological	Dabak and El tikaina	9.8810	-1.67460	-1.493	.155
	Abdalla Kadamoor	11.5556			

Table 4-15: t-test Analysis for Dabak and El tikaina project and El Jummuia projects.

Variables	name of project	Mean	Mean Difference	T	Sig.
Formal education	Dabak and El tikaina	5.64	-1.138	-.951	.791
	El Jummuia	6.78			
family size	Dabak and El tikaina	5.52	-1.062	-1.595	.635
	El Jummuia	6.59			
Family Education	Dabak and El tikaina	4.10	-1.197	-2.144	.149
	El Jummuia	5.29			
family farm labours	Dabak and El tikaina	.38	-.009	-.064	.579
	El Jummuia	.39			
Family income	Dabak and El tikaina	9663.81	-5916.434	-2.660	.054
	El Jummuia	15580.24			
Farmer income	Dabak and El tikaina	6893.33	-5795.203	-2.851	.039
	El Jummuia	12688.54			
Land area	Dabak and El tikaina	2.67	-11.029	-5.211	.000
	El Jummuia	13.70			
Wheat area	Dabak and El tikaina	1.93	-5.058	-4.068	.000
	El Jummuia	6.99			
Wheat production	Dabak and El tikaina	10.56	-32.294	-3.573	.000
	El Jummuia	42.85			
Wheat consumed	Dabak and El tikaina	1.31	-1.715	-2.170	.270
	El Jummuia	3.02			
Wheat sold	Dabak and El tikaina	9.25	-30.823	-3.645	.000
	El Jummuia	40.07			
gross income wheat	Dabak and El tikaina	221.43	-1550.767	-3.337	.000
	El Jummuia	1772.20			
Total amount of finance received by respondent	Dabak and El tikaina	1004.76	-1462.921	-3.831	.000
	El Jummuia	2467.68			
Adoption of wheat production Technological	Dabak and El tikaina	9.8810	-10.19222	-10.548	.009
	El Jummuia	20.0732			

4.3.1.14 Dabak and El tikaina and Wad Ramli

From Table 4.16 and the detailed results of t-test analysis, there are significant differences between *Dabak and El tikaina and Wad Ramli* projects in terms of:

1. Land area (mean scores being 2.67 and 8.05 respectively),
2. Wheat area (mean scores being 1.93 and 4.83 respectively),
3. Wheat production (mean scores being 10.56 and 25.30 respectively),
4. Wheat sold (mean scores being 9.25 and 23.16 respectively), and
5. Wheat finance amount (mean scores being 1004.76 and 2434.76 respectively).

4.3.1.15 Dabak and El tikaina and El Isailat

From Table 4.17 and the detailed results of t-test analysis, there are significant differences between *Dabak and El tikaina and El Isailat* projects in terms of:

1. Formal education (mean scores being 5.64 and 12.67 respectively),
2. Family labour (mean scores being .38 and .00 respectively),
3. Land area (mean scores being 2.67 and 25.00 respectively),
4. Wheat area (mean scores being 1.93 and 25.00 respectively),
5. Wheat production (mean scores being 10.56 and 20.00 respectively),
6. Wheat consumption (mean scores being 1.31 and 6.67 respectively), and
7. Wheat sold (mean scores being 9.25 and 13.33 respectively).

Table 4-16: t-test Analysis for Dabak and El tikaina project and Wad Ramli projects.

Variables	name of project	Mean	Mean Difference	T	Sig.
Formal education	Dabak and El tikaina	5.64	-5.024	-3.529	.235
	Wad Ramli	10.67			
Family size	Dabak and El tikaina	5.52	.619	.780	.376
	Wad Ramli	4.90			
Family Education	Dabak and El tikaina	4.10	-.619	-.883	.475
	Wad Ramli	4.71			
Family farm labours	Dabak and El tikaina	.38	-.190	-.891	.239
	Wad Ramli	.57			
Family income	Dabak and El tikaina	9663.81	120.952	.057	.762
	Wad Ramli	9542.86			
Farmer income	Dabak and El tikaina	6893.33	-478.095	-.274	.410
	Wad Ramli	7371.43			
Land area	Dabak and El tikaina	2.67	-5.376	-2.182	.000
	Wad Ramli	8.05			
Wheat area	Dabak and El tikaina	1.93	-2.899	-2.464	.000
	Wad Ramli	4.83			
Wheat production	Dabak and El tikaina	10.56	-14.738	-1.420	.005
	Wad Ramli	25.30			
Wheat consumed	Dabak and El tikaina	1.31	.345	.443	.229
	Wad Ramli	.96			
Wheat sold	Dabak and El tikaina	9.25	-13.907	-1.374	.003
	Wad Ramli	23.16			
gross income wheat	Dabak and El tikaina	221.43	-32.143	-.184	.737
	Wad Ramli	253.57			
Total amount of finance received by respondent	Dabak and El tikaina	1004.76	-1430.000	-2.734	.000
	Wad Ramli	2434.76			
Adoption of wheat production Technological	Dabak and El tikaina	9.8810	-7.45238	-8.110	.995
	Wad Ramli	17.3333			

Table 4-17: t-test Analysis for Dabak and El tikaina project and El Isailat projects.

Variables	name of project	Mean	Mean Difference	T	Sig.
Formal education	Dabak and El tikaina	5.64	-7.024	-2.974	.041
	El Isailat	12.67			
family size	Dabak and El tikaina	5.52	.857	.624	.855
	El Isailat	4.67			
Family Education	Dabak and El tikaina	4.10	.095	.081	.629
	El Isailat	4.00			
family farm labours	Dabak and El tikaina	.38	.381	1.211	.016
	El Isailat	.00			
Family income	Dabak and El tikaina	9663.81	2063.810	.647	.194
	El Isailat	7600.00			
Farmer income	Dabak and El tikaina	6893.33	1293.333	.532	.182
	El Isailat	5600.00			
Land area	Dabak and El tikaina	2.67	-22.329	-4.179	.000
	El Isailat	25.00			
Wheat area	Dabak and El tikaina	1.93	-23.073	-4.330	.000
	El Isailat	25.00			
Wheat production	Dabak and El tikaina	10.56	-9.440	-1.361	.000
	El Isailat	20.00			
Wheat consumed	Dabak and El tikaina	1.31	-5.357	-2.667	.000
	El Isailat	6.67			
Wheat sold	Dabak and El tikaina	9.25	-4.083	-.780	.002
	El Isailat	13.33			
gross income wheat	Dabak and El tikaina	221.43	221.429	.745	.122
	El Isailat	.00			
Total amount of finance received by respondent	Dabak and El tikaina	1004.76	-8995.238	-33.401	.108
	El Isailat	10000.00			
Adoption of wheat production Technological	Dabak and El tikaina	9.8810	6.71429	4.562	.178
	El Isailat	3.1667			

4.3.1.16 Abdalla Kadamoor and El Jummuia

From Table 4.18 and the detailed results of t-test analysis, there are significant differences between *Abdalla Kadamoor and El Jummuia* projects in terms of:

1. Land area (mean scores being 1.78 and 13.70 respectively),
2. Wheat area (mean scores being 1.56 and 6.99 respectively),
3. Wheat production (mean scores being 10.67 and 42.85 respectively),
4. Wheat sold (mean scores being 10.11 and 40.07 respectively),
5. Wheat gross income (mean scores being 44.44 and 1772.20 respectively), and
6. Wheat finance amount (mean scores being 966.67 and 2467.68 respectively).

4.3.1.17 Abdalla Kadamoor and Wad Ramli

From Table 4.19 and the detailed results of t-test analysis, there are significant differences between *Abdalla Kadamoor and El Wad Ramli* projects in terms of:

1. Land area (mean scores being 1.78 and 8.05 respectively),
2. Wheat area (mean scores being 1.56 and 4.83 respectively),
3. Wheat gross income (mean scores being 44.44 and 253.57 respectively), and
4. Wheat finance amount (mean scores being 966.67 and 2434.76 respectively).

Table 4-18: t-test Analysis for Abdalla Kadamoor project and El Jummuia projects.

Variables	name of project	Mean	Mean Difference	T	Sig.
Formal education	Abdalla Kadamoor	2.89	-3.892	-2.038	.784
	El Jummuia	6.78			
Family size	Abdalla Kadamoor	7.56	.970	.880	.933
	El Jummuia	6.59			
Family Education	Abdalla Kadamoor	5.56	.263	.292	.551
	El Jummuia	5.29			
Family farm labours	Abdalla Kadamoor	.33	-.057	-.289	.498
	El Jummuia	.39			
Family income	Abdalla Kadamoor	9244.44	-6335.799	-1.485	.173
	El Jummuia	15580.24			
Farmer income	Abdalla Kadamoor	3444.44	-9244.092	-2.326	.063
	El Jummuia	12688.54			
Land area	Abdalla Kadamoor	1.78	-11.922	-2.611	.006
	El Jummuia	13.70			
Wheat area	Abdalla Kadamoor	1.56	-5.430	-2.046	.028
	El Jummuia	6.99			
Wheat production	Abdalla Kadamoor	10.67	-32.187	-1.674	.053
	El Jummuia	42.85			
Wheat consumed	Abdalla Kadamoor	.56	-2.469	-1.850	.075
	El Jummuia	3.02			
Wheat sold	Abdalla Kadamoor	10.11	-29.962	-1.655	.045
	El Jummuia	40.07			
gross income wheat	Abdalla Kadamoor	44.44	-1727.751	-1.759	.011
	El Jummuia	1772.20			
Total amount of finance received by respondent	Abdalla Kadamoor	966.67	-1501.016	-1.872	.019
	El Jummuia	2467.68			
Adoption of wheat production Technological	Abdalla Kadamoor	11.5556	-8.51762	-4.514	.127
	El Jummuia	20.0732			

Table 4-19: t-test Analysis for Abdalla Kadamoor project and Wad Ramli projects.

Variables	name of project	Mean	Mean Difference	T	Sig.
Formal education	Abdalla Kadamoor	2.89	-7.778	-4.150	.618
	Wad Ramli	10.67			
Family size	Abdalla Kadamoor	7.56	2.651	2.352	.680
	Wad Ramli	4.90			
Family Education	Abdalla Kadamoor	5.56	.841	.827	.811
	Wad Ramli	4.71			
Family farm labours	Abdalla Kadamoor	.33	-.238	-.764	.124
	Wad Ramli	.57			
Family income	Abdalla Kadamoor	9244.44	-298.413	-.089	.495
	Wad Ramli	9542.86			
Farmer income	Abdalla Kadamoor	3444.44	-3926.984	-1.474	.072
	Wad Ramli	7371.43			
Land area	Abdalla Kadamoor	1.78	-6.270	-1.173	.049
	Wad Ramli	8.05			
Wheat area	Abdalla Kadamoor	1.56	-3.271	-1.323	.028
	Wad Ramli	4.83			
Wheat production	Abdalla Kadamoor	10.67	-14.631	-.664	.149
	Wad Ramli	25.30			
Wheat consumed	Abdalla Kadamoor	.56	-.409	-.546	.504
	Wad Ramli	.96			
Wheat sold	Abdalla Kadamoor	10.11	-13.046	-.600	.141
	Wad Ramli	23.16			
gross income wheat	Abdalla Kadamoor	44.44	-209.127	-1.251	.032
	Wad Ramli	253.57			
Total amount of finance received by respondent	Abdalla Kadamoor	966.67	-1468.095	-1.325	.004
	Wad Ramli	2434.76			
Adoption of wheat production Technological	Abdalla Kadamoor	11.5556	-5.77778	-3.777	.849
	Wad Ramli	17.3333			

4.3.1.18 Abdalla Kadamoor and El Isailat

From Table 4.20 and the detailed results of t-test analysis, there are significant differences between *Abdalla Kadamoor and El Isailat* projects in terms of:

1. Family labour (mean scores being .33 and .00 respectively),
2. Land area (mean scores being 1.78 and 25.00 respectively),
3. Wheat area (mean scores being 1.56 and 25.00 respectively),
4. Wheat production (mean scores being 10.67 and 20.00 respectively),
5. Wheat consumed (mean scores being .56 and 6.67 respectively), and
6. Wheat sold (mean scores being 10.11 and 13.33 respectively).

4.3.1.19 El Jummuia and Wad Ramli

From Table 4.21 and the detailed results of t-test analysis, there are significant differences between *El Jummuia and Wad Ramli* projects in terms of:

1. Family labour (mean scores being .39 and .57 respectively),
2. Wheat consumed (mean scores being 3.02 and .96 respectively), and

Wheat gross income (mean scores being 1772.20 and 253.57 respectively).

Table 4-20: t-test Analysis for Abdalla Kadamoor project and El Isailat projects.

Variables	name of project	Mean	Mean Difference	T	Sig.
Formal education	Abdalla Kadamoor	2.89	-9.778	-4.352	.069
	El Isailat	12.67			
Family size	Abdalla Kadamoor	7.56	2.889	1.661	.791
	El Isailat	4.67			
Family Education	Abdalla Kadamoor	5.56	1.556	1.063	.842
	El Isailat	4.00			
Family farm labours	Abdalla Kadamoor	.33	.333	1.612	.000
	El Isailat	.00			
Family income	Abdalla Kadamoor	9244.44	1644.444	.463	.605
	El Isailat	7600.00			
Farmer income	Abdalla Kadamoor	3444.44	-2155.556	-1.645	.720
	El Isailat	5600.00			
Land area	Abdalla Kadamoor	1.78	-23.222	-1.933	.009
	El Isailat	25.00			
Wheat area	Abdalla Kadamoor	1.56	-23.444	-1.951	.009
	El Isailat	25.00			
Wheat production	Abdalla Kadamoor	10.67	-9.333	-.875	.000
	El Isailat	20.00			
Wheat consumed	Abdalla Kadamoor	.56	-6.111	-1.774	.000
	El Isailat	6.67			
Wheat sold	Abdalla Kadamoor	10.11	-3.222	-.434	.001
	El Isailat	13.33			
gross income wheat	Abdalla Kadamoor	44.44	44.444	.806	.088
	El Isailat	.00			
Total amount of finance received by respondent	Abdalla Kadamoor	966.67	-9033.333	-116.786	.121
	El Isailat	10000.00			
Adoption of wheat production Technological	Abdalla Kadamoor	11.5556	8.38889	3.913	.302
	El Isailat	3.1667			

Table 4-21: t-test Analysis for El Jummuia project and Wad Ramli projects.

Variables	name of project	Mean	Mean Difference	t	Sig.
Formal education	El Jummuia	6.78	-3.886	-2.918	.258
	Wad Ramli	10.67			
Family size	El Jummuia	6.59	1.681	2.229	.610
	Wad Ramli	4.90			
Family Education	El Jummuia	5.29	.578	.899	.607
	Wad Ramli	4.71			
Family farm labours	El Jummuia	.39	-.181	-1.008	.018
	Wad Ramli	.57			
Farmer income to family	El Jummuia	15580.24	6037.387	2.021	.226
	Wad Ramli	9542.86			
Farmer income	El Jummuia	12688.54	5317.108	1.869	.315
	Wad Ramli	7371.43			
Land area	El Jummuia	13.70	5.652	1.464	.916
	Wad Ramli	8.05			
Wheat area	El Jummuia	6.99	2.159	1.044	.846
	Wad Ramli	4.83			
Wheat production	El Jummuia	42.85	17.556	1.090	.880
	Wad Ramli	25.30			
Wheat consumed	El Jummuia	3.02	2.060	2.271	.038
	Wad Ramli	.96			
Wheat sold	El Jummuia	40.07	16.916	1.094	.949
	Wad Ramli	23.16			
Gross income wheat	El Jummuia	1772.20	1518.624	2.356	.001
	Wad Ramli	253.57			
Total amount of finance received by respondent	El Jummuia	2467.68	32.921	.045	.107
	Wad Ramli	2434.76			
Adoption of wheat production Technological	El Jummuia	20.0732	2.73984	2.025	.076
	Wad Ramli	17.3333			

4.3.1.20 El Jummuia and El Isailat

From Table 4.22 and the detailed results of t-test analysis, there are significant differences between *El Jummuia and El Isailat* projects in terms of:

1. Formal Education (mean scores being 6.78 and 12.67 respectively),
2. Family labour (mean scores being .39 and .00 respectively),
3. Land area (mean scores being 13.70 and 25.00 respectively),
4. Wheat area (mean scores being 6.99 and 25.00 respectively),
5. Wheat consumption (mean scores being 3.02 and 6.67 respectively),
6. Wheat gross income (mean scores being 1772.20 and .00 respectively), and
7. Wheat finance amount (mean scores being 2467.68 and 10000.00 respectively).

4.3.1.21 Wad Ramli and El Isailat

From Table 4.23 and the detailed results of t-test analysis, there are significant differences between *El Jummuia and Wad Ramli* projects in terms of:

8. Family labour (mean scores being .57 and .00 respectively),
9. Land area (mean scores being 8.05 and 25.00 respectively),
10. Wheat area (mean scores being 4.83 and 25.00 respectively),
11. Wheat consumption (mean scores being .96 and 6.67 respectively),
12. Wheat gross income (mean scores being 253.57 and .00 respectively), and

Wheat finance amount (mean scores being 2434.76 and 10000.00 respectively).

Table 4-22: t-test Analysis for El Jummuia project and El Isailat projects.

Variables	Name of project	Mean	Mean Difference	T	Sig.
Formal education	El Jummuia	6.78	-5.886	-2.731	.020
	El Isailat	12.67			
Family size	El Jummuia	6.59	1.919	1.489	.654
	El Isailat	4.67			
Family Education	El Jummuia	5.29	1.293	1.225	.814
	El Isailat	4.00			
Family farm labours	El Jummuia	.39	.390	1.747	.000
	El Isailat	.00			
Family income	El Jummuia	15580.24	7980.244	1.574	.121
	El Isailat	7600.00			
Farmer income	El Jummuia	12688.54	7088.537	1.457	.149
	El Isailat	5600.00			
Land area	El Jummuia	13.70	-11.300	-1.459	.006
	El Isailat	25.00			
Wheat area	El Jummuia	6.99	-18.015	-2.876	.000
	El Isailat	25.00			
Wheat production	El Jummuia	42.85	22.854	.952	.647
	El Isailat	20.00			
Wheat consumed	El Jummuia	3.02	-3.642	-1.654	.000
	El Isailat	6.67			
Wheat sold	El Jummuia	40.07	26.740	1.193	.367
	El Isailat	13.33			
gross income wheat	El Jummuia	1772.20	1772.195	1.472	.030
	El Isailat	.00			
Total amount of finance received by respondent	El Jummuia	2467.68	-7532.317	-7.664	.039
	El Isailat	10000.00			
Adoption of wheat production Technological	El Jummuia	20.0732	16.90650	7.121	.803
	El Isailat	3.1667			

Table 4-23: t-test Analysis for Wad Ramli project and El Isailat projects.

Variables	name of project	Mean	Mean Difference	T	Sig.
Formal education	Wad Ramli	10.67	-2.000	-1.052	.102
	El Isailat	12.67			
family size	Wad Ramli	4.90	.238	.189	.402
	El Isailat	4.67			
Family Education	Wad Ramli	4.71	.714	.613	.949
	El Isailat	4.00			
family farm labours	Wad Ramli	.57	.571	1.586	.002
	El Isailat	.00			
Farmer income to family	Wad Ramli	9542.86	1942.857	.527	.228
	El Isailat	7600.00			
Farmer income	Wad Ramli	7371.43	1771.429	.546	.171
	El Isailat	5600.00			
Land area	Wad Ramli	8.05	-16.952	-1.686	.042
	El Isailat	25.00			
Wheat area	Wad Ramli	4.83	-20.174	-2.464	.001
	El Isailat	25.00			
Wheat production	Wad Ramli	25.30	5.298	.190	.780
	El Isailat	20.00			
Wheat consumed	Wad Ramli	.96	-5.702	-2.494	.000
	El Isailat	6.67			
Wheat sold	Wad Ramli	23.16	9.824	.363	.520
	El Isailat	13.33			
Gross income wheat	Wad Ramli	253.57	253.571	1.252	.022
	El Isailat	.00			
Total amount of finance received by respondent	Wad Ramli	2434.76	-7565.238	-5.558	.013
	El Isailat	10000.00			
Adoption of wheat production Technological	Wad Ramli	17.3333	14.16667	6.988	.410
	El Isailat	3.1667			

4-4 Results of correlation analysis

The inter-correlation matrix of the study variables constituting the conceptual model is located in Table 4.24. The determination of the correlates of the model variables reported below is based on the significant associations between the variables. The significant predictors of the each of the variables in the model are different.

4-4-1 Predictors of access to agricultural extension services

Variables with significant associations with access to agricultural extension services were found to be participation in project development activities (r= .372), adoption of improved wheat production technology (r= .227), formal education (r= .181), family size (r= .035), gross income from wheat production (r= -.123), and total farmland area in possession (r = .029). Age of respondents and total production of wheat in sacks did not associate significantly with access to agricultural extension services.

4-4-1-2 Predictors of participation in project development activities

Variables with significant associations with participation in project development activities were found to be access to agricultural extension services (r= .372), adoption of improved wheat production technology (r= .308), age for respondent (r= .286), family size (r= .183), total production of wheat in sacks (r= .281) and total farmland area in possession (r= .224). Formal education, gross income to respondent from wheat production did not associate significantly with participation in project development activities.

Table 4.24: Matrix of inter-correlations between variables in the conceptual causal model of the study									
	X1	X2	X3	X4	X5	X6	X7	X8	X9
X1	1	.372**	.227**	.159	.181**	.035**	-.090	-.123**	.029**
X2		1	.308**	.286**	.194	.183**	.281**	.203	.224**
X3			1	.242**	-.029**	.184	.130**	.175**	.137
X4				1	-.466**	.693**	-.031	.006**	.088**
X5					1*	-.382	.151*	.042*	.136
X6						1*	.094	.084*	.194*
X7							1	.760**	.670
X8								1*	.410*
X9									1

**. Correlation is significant at the 0.01 level .

*. Correlation is significant at the 0.05 level

X5= formal education

X6= Family size

X7= Total production of wheat in sacks

X8= Gross income to respondent from wheat production

X9= Total farmland area in possession

X1= access to agricultural extension services

X2= participation in project development activities

X3= adoption of improved wheat production technology

X4= Age for respondent

4-4-1-3 Predictors of adoption of improved wheat production technology

Variables with significant associations with adoption of improved wheat production technology were found to be access to agricultural extension services (r= .227), participation in project development activities (r= .308), age for respondent (r= .242), formal education (r= -.029), total production of wheat in sacks (r= .130), gross income to respondent from wheat production (r= .175). Family size and total farmland area in possession did not associate significantly with adoption of improved wheat production technology.

4-4-1-4 Predictors of gross income to respondent from wheat production

Variables with significant associations with gross income to respondent from wheat production were found to be access to agricultural extension services (r= -.123), adoption of improved wheat production technology (r=.173), age for respondent (r= .006), formal education (r= .042), family size (r= .084), total production of wheat in sacks (r= .760), total farmland area in possession (r= .410). Participation in project development activities did not associate significantly with gross income to respondent from wheat production.

4-4-1-5 Predictors of total production of wheat in sacks

Variables with significant associations with total production of wheat in sacks were found to be participation in project development activities (r= .281), adoption of improved wheat production technology (r= .130), formal education (r= .151), gross income to respondent from wheat production (r= .760). Access to agricultural extension services,

age, family size, and total farmland area in possession did not associate significantly with total production of wheat in sacks.

4-4-1-6 Predictors of total farmland area in possession

Variables with significant associations with total farmland area in possession were found to be access to agricultural extension services (r = .029), participation in project development activities (r = .224), age for respondent (r = .088), family size (r = .194), gross income to respondent from wheat production (r = .410). Adoption of improved wheat production technology, formal education, and total production of wheat in sacks did not associate significantly with total farmland area in possession.

4-4-1-7 Predictors of family size

Variables with significant associations with family size were found to be access to agricultural extension services (r= .035), participation in project development activities (r= .183), age for respondent (r= .693), gross income to respondent from wheat production (r= .084) and total farmland area in possession (r= .194). Adoption of improved wheat production technology, formal education, and total production of wheat in sacks did not associate significantly with family size.

4-4-1-8 Predictors of formal education

Variables with significant associations with formal education were found to be access to agricultural extension services (r= .181), adoption of improved wheat production technology (r= -.029), age for respondent (r=-.466), total production of wheat in sacks (r= .151), gross income to respondent from wheat production (r= .042).

4-4-1-9 Predictors of age for respondent

Variables with significant associations with age were found to be participation in project development activities (r = .286), adoption of improved wheat production technology (r = .242), formal education (r= -.466), Family size (r= .693), gross income to respondent from wheat production (r= .006), total farmland area in possession (r= .088).

4-4-2 Results of multiple regression analysis

For building of a causal model evaluation of the impact of extension programs on adoption of improved wheat production technology in Khartoum state, 9 variables were used, multiplied regression analysis was conducted to estimate the direct effects on the endogenous variables of the model. The variables were used in standard for generating beta weights, which are used for comparing the relative strength of the effects of casual variables on each of the endogenous variables. The value of beta coefficients determines the relative strength of the relationships between the dependent variable and the causal independent variables.

4-4-2-1 Determinants of gross income to respondent from wheat production

The testing of the hypothesis on determinants of gross income to respondent from wheat production involved regression of this variable on age for respondent, formal education, family size, total farmland area in possession, total production of wheat in sacks, total amount of finance received, participation in project development activities, adoption of

improved wheat production technology, and access to agricultural extension services.

The results of enter regression analysis in table 4.25 indicate that total farmland area in possession (beta= -.180) and total production of wheat in sacks (beta= .874) are the only significant determinants of gross income to respondent from wheat production. Thus, hypothesis 1 is partially supported by regression analysis results.

4-4-2-2 Determinants of total production of wheat in sacks

The testing of the hypothesis on determinants of total production of wheat in sacks among respondents, involved regression of this variable on age for respondent, formal education, family size, total farmland area in possession, total amount of finance received by respondent, participation in project development activities, adoption of improved wheat production technology, and access to agricultural extension services.

The results of enter regression analysis in table 4.26 indicate that total production of wheat in sacks is significantly determined by age for respondent (beta= -.181), total farmland area in possession (beta= .524), total amount of finance received (beta= .154) and participation in project development activities (beta= .244), and access to agricultural extension services (beta= -.171). Thus, hypothesis 2 is partially supported by regression analysis results.

Table 4.25: Multiple regression of gross income to respondent from wheat production

Summary of the regression			
Regression	.781[a]		
R square	.610		
Adjusted R square	.585		
Standard error of the estimate	1116.182		
	Df	Sum of square	Mean square
Regression	9	272699380.201	30299931.133
Residual	140	174420644.633	1245861.747
F = 24.320		Sig. F = .000b	

Variables included in the equation					
Variable	B	SEB	Beta	T	Sig. T
Age	2.587	10.581	.021	.245	.807
Formal education	-14.468	21.255	-.046	-.681	.497
Family size	-5.809	45.557	-.010	-.128	.899
total farmland area in possession	-23.142	10.841	-.180	-2.135	.035
Total production of wheat in sacks	36.140	3.172	.874	11.394	.000
Total amount of finance received	.000	.051	.000	-.006	.995
Participation in project development activities	-1.522	14.334	-.007	-.106	.916
Adoption of improved wheat production technology	27.326	17.435	.095	1.567	.119
Access to agricultural extension services	-62.267	72.340	-.052	-.861	.391
Constant	-232.861	529.028			.660

Table 4.26: Multiple regression of total production of wheat in sacks

Summary of the regression					
Regression		.726[a]			
R square		.527			
Adjusted R square		.500			
Standard error of the estimate		29.636			
	Df	Sum of square	Mean square		
Regression	8	137871.193	17233.899		
Residual	145	123839.665	878.295		
F = 19.622		**Sig. F = .000[b]**			
Variables included in the equation					
Variable	B	SEB	Beta	T	Sig. T
Age	-.547	.277	-.181	-1.975	.050
Formal education	-.209	.564	-.028	-.371	.711
Family size	1.017	1.207	.071	.842	.401
total farmland area in possession	1.630	.253	.524	6.443	.000
Total amount of finance received	.003	.001	.154	1.902	.059
Participation in project development activities	1.268	.365	.244	3.472	.001
Adoption of improved wheat production technology	.612	.460	.088	1.331	.185
Access to agricultural Extension services	-4.964	1.875	-.171	-2.648	.009
Constant	17.609	13.968		1.261	.210

4-4-2-3 Determinants of adoption of improved wheat production technology

The testing of the hypothesis on determinants of adoption of improved wheat production technology involved regression of this variable on age for respondent, formal education, family size, total farmland area in possession, total amount of finance received, participation in project development activities, and access to agricultural extension services.

The results of enter regression analysis in table 4.27 indicate that adoption of improved wheat production technology is significantly determined by total farmland area in possession (beta= .332), total amount of finance received (beta= -.407) and participation in project development activities (beta= .165). Thus, hypothesis 3 is partially supported by regression analysis results.

4-4-2-4 Determinants of total amount of finance received by respondent

The testing of the hypothesis on determinants of total amount of finance received by respondent, involved regression of this variables on age for respondent, formal education, family size, total farmland area in possession, participation in project development activities, and access to agricultural extension services.

The results of enter regression analysis in table 4.28 indicate that three variables affect the total amount of finance received by the respondents, namely formal education (beta= .140), family size (beta= -.201), and total farmland area in possession (beta= .631). Thus, hypothesis 6 is partially supported by regression analysis results.

Table 4.27: Multiple regression of adoption of improved wheat production technology

Summary of the regression			
Regression		.485[a]	
R square		.235	
Adjusted R square		.197	
Standard error of the estimate		5.40618	
	Df	Sum of square	Mean square
Regression	7	1273.587	181.941
Residual	142	4150.206	29.227
F = 6.225		**Sig. F = .000[b]**	

Variables included in the equation					
Variable	B	SEB	Beta	T	Sig. T
Age	.059	.050	.136	1.172	.243
Formal education	.020	.103	.018	.191	.848
Family size	-.099	.220	-.048	-.450	.653
Total farmland area in possession	.149	.044	.332	3.345	.001
Total amount of finance received	-.001	.000	-.407	-4.198	.000
Participation in project development activities	.124	.066	.165	1.876	.063
Access to agricultural extension services	.405	.340	.097	1.191	.236
Constant	11.002	2.375		4.633	.000

Table 4.28: Multiple regression of Total amount of of finance received by respondent by respondent

Summary of the regression			
Regression		.654[a]	
R square		.428	
Adjusted R square		.404	
Standard error of the estimate		1967.847	
	Df	Sum of square	Mean square
Regression	6	413989231.929	68998205.321
Residual	143	553756587.405	3872423.688
F = 17.818		**Sig. F = .000[b]**	

Variables included in the equation					
Variable	B	SEB	Beta	T	Sig. T
Age	10.675	18.291	.058	.584	.560
formal education	64.847	37.055	.140	1.750	.082
Family size	-174.810	78.713	-.201	-2.221	.028
Total farmland area in possession	119.515	12.717	.631	9.398	.000
Access to agricultural extension services	-162.060	123.117	-.092	-1.316	.190
Participation in project development activities	-35.089	23.780	-.111	-1.476	.142
Constant	1659.429	853.233		1.945	.054

4-4-2-5 Determinants of participation in project development activities

The testing of the hypothesis on determinants of participation in project development activities among respondents, involved regression of this variable on age for respondent, formal education, family size, total farmland area in possession, and access to agricultural extension services.

The results of enter regression analysis in table 4.29 indicate that four variables affect participation in project development activities significantly, namely age of respondent (beta= .372), formal education (beta= .304), total farmland area in possession (beta= .142), and access to agricultural extension services (beta= .253). Thus, hypothesis 4 is partially supported by regression analysis results.

4-4-2-6 Determinants of access to agricultural extension services

The testing of the hypothesis on determinants of access to agricultural extension services among respondents, involved regression of this variables on age for respondent, formal education, family size, total farmland area in possession. (Table 5.9).

The results of enter regression analysis in table 4.30 indicate that variables affects access to agricultural extension services significantly, age for respondent (beta= .383), formal education (beta= .325). Thus, hypothesis 5 is partially supported by regression analysis results.

Table 4.29: Multiple regression of participation in project development activities

Summary of the regression			
Regression		.541[a]	
R square		.292	
Adjusted R square		.268	
Standard error of the estimate		6.89604	
	Df	Sum of square	Mean square
Regression	5	2827.929	565.586
Residual	144	6847.964	47.555
F = 11.893		**Sig. F = .000[b]**	

Variables included in the equation					
Variable	B	SEB	Beta	T	Sig. T
Age	.216	.062	.372	3.505	.001
Formal education	.444	.124	.304	3.570	.000
Family size	.015	.276	.005	.054	.957
Total farmland area in possession	.085	.044	.142	1.929	.056
Access to agricultural extension services	1.411	.415	.253	3.398	.001
Constant	-9.627	2.880		-3.342	.001

Table 4.30: Multiple regression of access to agricultural extension services

Summary of the regression			
Regression		.340[a]	
R square		.115	
Adjusted R square		.091	
Standard error of the estimate		1.37955	
	Df	Sum of square	Mean square
Regression	4	36.014	9.004
Residual	145	275.959	1.903
F = 4.731		**Sig. F = .001[b]**	

Variables included in the equation					
Variable	B	SEB	Beta	T	Sig. T
Age	.040	.012	.383	3.371	.001
Formal education	.085	.024	.325	3.573	.000
Family size	-.050	.055	-.101	-.908	.365
Total farmland area in possession	-.003	.009	-.029	-.353	.724
Constant	-.316	.576		-.549	.584

4-4-2-7 Determinants of total farmland area in possession

The testing of the hypothesis on determinants of total farmland area in possession among respondents, involved regression of this variable on age for respondent, formal education, family size.

The results of enter regression analysis in table 4.31 indicate that two variables affect total farmland area in possession significantly, namely formal education (beta= .247) and family size (beta= .284). Thus, hypothesis 7 is partially supported by regression analysis results.

4-4-2-8 Determinants of Family size

The testing of the hypothesis on determinants of Family size among respondents, involved regression of this variable on age for respondent, formal education.

The results of enter regression analysis in table 4.32 indicate that one variable affects family size significantly, namely age for respondent (beta= .658).

4-4-2-9 Determinants of formal education

The testing of the hypothesis on determinants of formal education among respondents, involved regression of this variable on age for respondent.

The results of enter regression analysis in table 4.33 indicate that one variable affects formal education significantly, namely age for respondent (beta= -.466).

.**Table 4.31: Multiple regression of total farmland area in possession**

Summary of the regression			
Regression		.299[a]	
R square		.089	
Adjusted R square		.071	
Standard error of the estimate		12.976	
	Df	Sum of square	Mean square
Regression	3	2410.579	803.526
Residual	146	24584.113	168.384
F = 4.772		**Sig. F = .003[b]**	

Variables included in the equation					
Variable	B	SEB	Beta	T	Sig. T
Age	.006	.111	.006	.054	.957
formal education	.604	.219	.247	2.759	.007
Family size	1.307	.506	.284	2.582	.011
Constant	-4.832	5.400		-.895	.372

Table 4.32: Multiple regression of family size

Summary of the regression					
Regression	.697[a]				
R square	.485				
Adjusted R square	.478				
Standard error of the estimate	2.115				
	Df	Sum of square	Mean square		
Regression	2	619.707	309.853		
Residual	147	657.287	4.471		
F = 69.298		**Sig. F = .000[b]**			
Variables included in the equation					
Variable	B	SEB	Beta	T	Sig. T
Age	.139	.014	.658	9.843	.000
formal education	-.040	.036	-.075	-1.124	.263
Constant	-.744	.878		-.847	.398

Table 4.33: Multiple regression of formal education

Summary of the regression					
Regression		.466[a]			
R square		.217			
Adjusted R square		.212			
Standard error of the estimate		4.894			
	Df	Sum of square	Mean square		
Regression	1	984.615	984.615		
Residual	148	3544.718	23.951		
F = 41.110		**Sig. F = .000[b]**			
Variables included in the equation					
Variable	B	SEB	Beta	T	Sig. T
Age	-.185	.029	-.466	-6.412	.000
Constant	16.446	1.516		10.845	.000

4-4-3 Revised causal of the impact of extension programs on adoption of improved wheat production technology in Khartoum state.

The revised causal model, showed in figure 4.1, is based on the results generated by enter regression procedure. According to table 4.34, the variables that most significantly affect gross income to respondent from wheat production are total production of wheat in sacks (total effect = .874), adoption of improved wheat production technology (total effect = .095), total amount of finance received (total effect = .0959), participation in project development activities (total effect = .2289), access to agricultural extension services (total effect = -.0915), total farmland area in possession (total effect = .4026), formal education (total effect = .0613), age for respondent (total effect = .0019), family size (total effect = .1462).

As shown in table 4.34, the variable that most significantly determine access to agricultural extension services are formal education (total effect = .325), age (total effect = .2315). The table also shows that the variables that most significantly affect participation in project development activities are access to agricultural extension services (total effect = .253), formal education (total effect = .4213), age for respondent (total effect = .3757), total farmland area in possession (total effect = .142) and family size (total effect = .0403).

The variables that most significantly affects total amount of finance received in a negative manner are family size (total effect =-.0218), formal education (total effect =.140), total farmland area in possession (total effect =.631), age for respondent (total effect =-.1522).

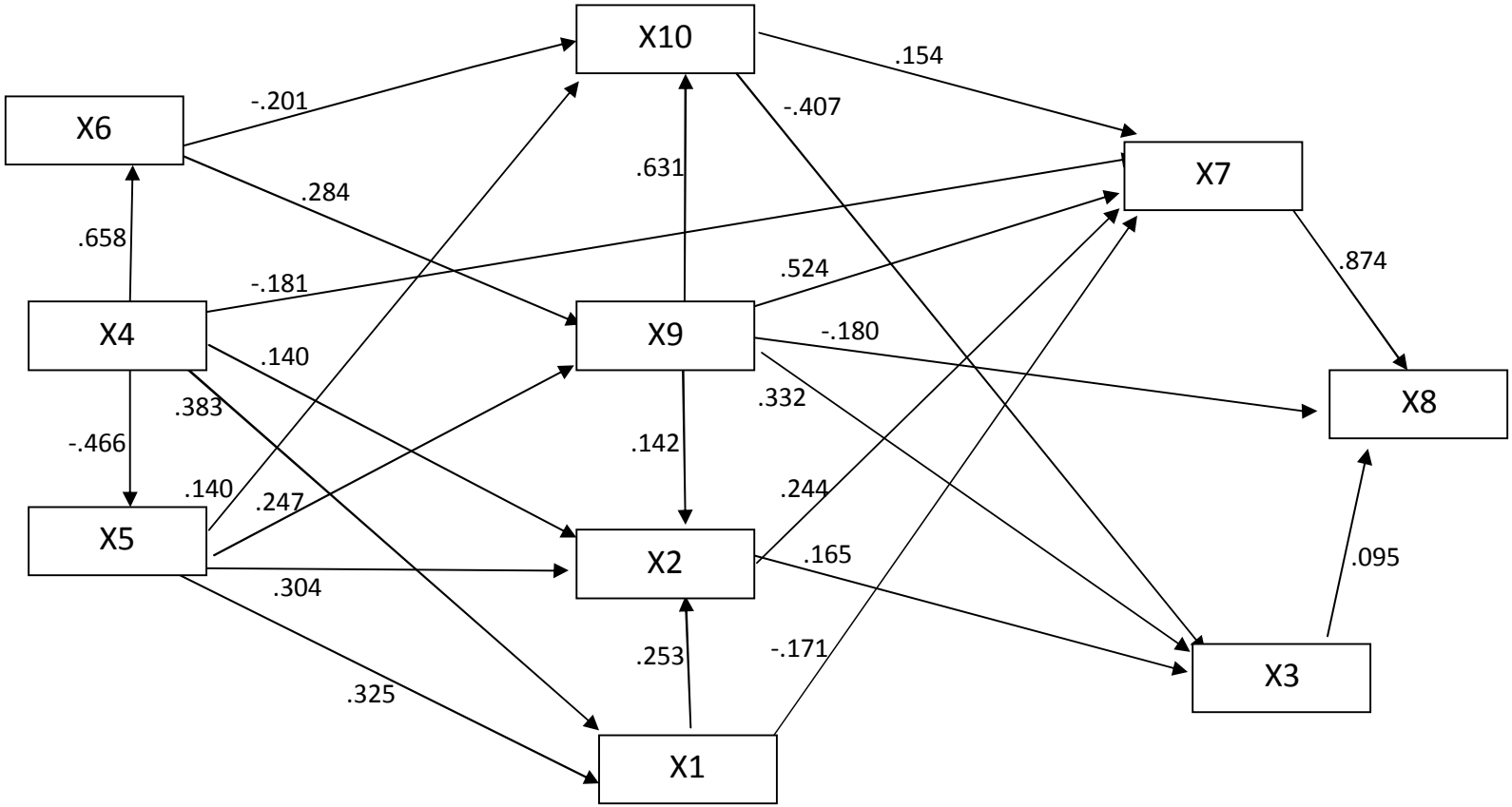

Figure 4.1: Revised casual model of the impact of extension programs on adoption of improved wheat production technology in Khartoum State

Key:

X1= access to agricultural extension services

X2= participation in project development activities

X3= adoption of improved wheat production technology

X4= Age for respondent

X6= Family size

X7= Total production of wheat in sacks

X8= Gross income to respondent from wheat production

X9= Total farmland area in possession

REVISED PATH MODEL

Table 4.34: Results of the impact of extension programs on adoption of improved wheat production technology in Khartoum state.

Dependent variable	**Determinants**	**Direct effect**	**Indirect effect**	**Total effect**
Gross wheat income	Total production of wheat in sacks	.874		.874
	Adoption of improved wheat production technology	.095		.095
	Total amount of finance received		.0959	.096
	Participation in project development activities		.2289	.229
	Access to agricultural extension services		-.0915	-.092
	Total farmland area in possession	-.180	.5826	.403
	formal education		.0613	.0613
	Age		.0019	.0019
	Family size		.1462	.1462
Access to agricultural extension services	formal education	.325		.325
	Age	.383	-.1515	.2315
Participation in project development activities	Access to agricultural extension services	.253		.253
	formal education	.304	.1173	.4213
	Age	.372	.0037	.3757
	Total farmland area in possession	.142		.142
	Family size		.0403	.0403
Total amount of finance received	Family size	-.201	.1792	-.0218
	formal education	.140		.140
	Total farmland area in possession	.631		.631
	Age		-.1522	-.1522

Dependent variable	Determinants	Direct effect	Indirect effect	Total effect
Adoption of improved wheat production technology	Participation in project development activities	.165		.165
	Total farmland area in possession	.332	-.2333	.0987
	Total amount of finance received	-.407		-.407
	formal education		.0311	.0311
	Age		.0629	.0629
	Access to agricultural extension services		.0417	.0417
	Family size		.0249	.0249
Total production of wheat in sacks	Total amount of finance received	.154		.154
	Age	-.181	.0476	-.1334
	Participation in project development activities	.244		.244
	Access to agricultural extension services	-.171	.0617	-.1093
	Total farmland area in possession	.524	.1318	.6558
	formal education		.2222	.2222
	Family size		.1553	.1553
Total farmland area in possession	formal education	.247		.247
	Family size	.284		.284
	Age		.0718	.0718
Family size	Age	.658		.658
Formal education	Age	-.466		-.466

The results in table 4.34 also reveal that adoption of improved wheat production technology is most significantly determined by participation in project development activities (total effect = .165), total farmland area in possession (total effect = .0987), total amount of finance received (total effect = -.407), formal education (total effect = .0311), age for respondent (total effect = .0629), access to agricultural extension services (total effect = .0417) and family size (total effect = .0249).

The results in table 4.34 also reveal that total production of wheat in sacks is most significantly determined by total amount of finance received (total effect = .154), age for respondent (total effect = -.1334), participation in project development activities (total effect = .244), access to agricultural extension services (total effect = -.1093), total farmland area in possession (total effect = .6558), formal education (total effect = .2222) and family size (total effect = .1553).

The results in table 4.34 also reveal that total farmland area in possession is most significantly determined by formal education (total effect = .247), family size (total effect = .284) and age for respondent (total effect = .0718). The results in table 5.13 also reveal that family size is most significantly determined by age for respondent (total effect = .658).

The table also shows that the variables that most significantly affect formal education is age for respondent (total effect = -.466).The significant effects from the different variables in the model are depicted graphically in Figure 5.1 The direct, indirect and total effects from the different determinants are computed from the revised causal model using the path analysis procedure and displayed in Table 5.34.

Chapter Five
SUMMARY, CONCLUSION AND RECOMMENDATIONS

5-1 Summary of the Research

The study was designed to the impact of the extension programs on adoption of wheat production assess the differences between projects in Khartoum state in season 2008/2009, along a set of variables relating to farmer characteristics and those relating to production of wheat.

The main objectives of the study reported in this thesis are to measure the impact of the extension programs on adoption of wheat production in Khartoum State. A conceptual model was developed as a framework for causal explanation of the impact of the extension programs and other factors on adoption of the wheat recommended wheat production package by farmers as a principal dependent variable affecting productivity and total production of wheat in seven selected wheat production projects. The model is focused on 10 variables, which are arranged in a logical casual order to provide for explanation of wheat production and income in Khartoum State, are namely participation in project development activities, adoption of improved wheat production technology, gross income from wheat production, total farmland area in possession, total production of wheat in sacks, total amount of finance received, access to agricultural extension services, age, formal education and family size.

For purposes of the study, a stratified random sampling method was used to select one hundred and fifty respondents from total of eight hundred eighty-five farmers engaged in wheat production in seven projects, namely El Jummuia, El Isailat, Wad Ramli, El Khojalab, Dabak and Eltikaina, El Sururab all of which are located in Khartoum state. The primary data for the study were collected through use of individual interviews, using of structured questionnaires, supported by personal observation. Different statistical procedures were used in data analysis, including frequency and percentage distribution tables, t-test, correlation analysis (to identify significant correlates of the model variables), and regression analysis (for testing the postulated causal model). Regression analysis constituted the principal procedure for extending casual explanation by means of the application of path analysis.

5.2 conclusions

5-2-1 Result of mean variables

1- Adoption of wheat production technological package: the highest rate in El Jummuia project 20.0 and low rate in El Isailat 3.17.

2- Productivity of wheat: the highest rate in Abdalla Kadamour 7.31 and lowest rate in El Sururab 3.68.

3- Formal education: the highest rate in El Isailat project 12.67 and lowest rate in Abdalla Kadamour 2.89.

4- Family size: the highest rate in Abdalla Kadamour 7.56 and lowest rate in El Isailat 4.67.

5- Family education: the highest rate in El Khojalab project 6.67and lowest rate in El Isailat 4.00.

6- Total number of family labour: the highest rate in El Khojalab project .83 and lowest rate in El Isailat .00.

7- Total income to family members in the year: the highest rate in the El Khojalab project 36650.000 and lowest in El Isailat 7600.00.

8- Total income in the year: the highest rate in El Khojalab project 18850.0 and lowest in Abdalla Kadamour 3444.44.

9- Total area (feddans) possession: The largest in El Isailat 25.00 and smallest in El Sururab 1.32.

10- Area (feddans) under wheat: The largest in El Jummuia 6.99 and smallest in El Sururab 1.32.

11- Total production wheat in sacks: The highest rate in El Jummuia 42.85 and lowest in El Sururab 4.48.

12- Amount of wheat consumed (in sacks): The highest rate in El Isailat 6.67 and lowest in El Sururab .00.

13- Amount of wheat sold (in sacks): the highest rate in El Jummuia 40.07 and lowest in El Sururab 4.48.

14- Gross income from wheat: the highest rate in El Jummuia 1772.20 and lowest in El Isailat .00.

15- Total amount of finance received by respondent: the highest rate in El Isailat 10000.00 and lowest rate in El Sururab 580.20.

6-2-2 The total productivity of wheat compared to all projects

1- Mean total wheat production: the highest mean in El Jummuia project (42.85 sacks) and the least in El Sururab 4.48.

2- Wheat productivity (sacks/feddan): the highest mean in Abdalla Kadamour (7.31 sacks per feddan) and the least in El Isailat (0.95 sacks per feddan).

5-2-3 The correlation analysis shows that

1- **Access to agricultural extension services:**

Significant with:

- participation in project development activities,

- adoption of improved wheat production technology,

- formal education,

- family size,

- gross income to respondent from wheat production, and

- total farmland area in possession.

2- **Participation in project**:

Significant with:

- access to agricultural extension services,

- adoption of improved wheat production technology,

- age for respondent,

- family size,

- total production of wheat in sacks, and

- total farmland area in possession.

3- **Adoption of imroved wheat production technology:**

Significant with:

- access to agricultural extension services,

- participation in project development activities,

- age for respondent,

- formal education,

- total production of wheat in sacks, and

- gross income to respondent from wheat production.

4- **Gross income to respondent from wheat production:**

Significant with:

- access to agricultural extension services,

- adoption of improved wheat production technology,

- age for respondent,

- formal education,

- family size,

- total production of wheat in sacks, and

- total farmland area in possession.

5- **Total production of wheat in sacks**:

Significant with:

- participation in project development activities,

- adoption of improved wheat production technology,

- formal education, and

- gross income to respondent from wheat production.

6- **Total farmland area in possession:**

Significant with:

- access to agricultural extension services,

- participation in project development activities,

- age for respondent,

- family size, and

- gross income to respondent from wheat production.

5-2-4 multiplied regression analysis was conducted to estimate the direct effects on the endogenous variables of the model. The value of beta coefficients determines the relative strength of the relationships between the dependent variable and the causal independent variables.

1- **Gross income to respondent from wheat production**:

Significant determinate of:

- total farmland area in possession, and

- total production of wheat in sacks.

2- **Total production of wheat in sacks**:

Significant determinate of:

- age for respondent,

- total farmland area in possession,

- total amount of finance received by respondent,

- participation in project development activities, and

- access to agricultural extension services.

3- **Adoption of improved wheat production technology**:

Significant determinate of:

- total farmland area in possession,

- total amount of finance received, and

- participation in project development activities.

4- **Total amount of finance received:**

Significant determinate of:

- formal education,

- family size, and

- total farmland area in possession.

5- **Participation in project development activities**:

Significant determinate of:

- age for respondent,

- formal education,

- total farmland area in possession, and

- access to agricultural extension services.

6- **Access to agricultural extension services:**

Significant determinate of:

- age for respondent, and

- formal education.

7- **Total farmland area in possession**:

Significant determinate of:

- formal education, and

- family size.

It is to be concluded that El Jummuia project has succeeded to achieve greater level of adoption of the recommended technological package for wheat production. This is attributed to high level of access to extension services, and the long wheat production experience of most of the participating farmers

5.3 Recommendations

On the basis of the findings of the study, the following set of recommendations was drawn:

5-3-1 Recommendations for the Ministry of Agriculture, Animal Resources and Irrigation, – Khartoum State:

1. It is recommended that the Ministry of Agriculture, Animal Resources and Irrigation, – Khartoum State provide support for the Technology Transfer and Extension Administration to enhance the capabilities of the staff and encourage greater participation in extension programs by the farmers.

2. It is recommended that the Ministry of Agriculture adopts policies that encourage the pooling of land recourses to form larger farming units capable of adoption to improve to packages and improved land preparation practices.
3. It is recommended that the Ministry of Agriculture adopts policies facilitate access to production inputs.
4. It is recommended that extension administration to support funding the extension works

5-3-2 Recommendations to the Technology Transfer and Extension Administration – Khartoum State:

1. It is recommended that Technology Transfer and Extension Administration studies the structure and production systems employed by the agricultural projects and their suitability for different types of agricultural technology packages.
2. It is recommended that Technology Transfer and Extension Administration conduct experiments suitability of the soil for planting with different crop varieties in collaboration with the project administrations and the agricultural research corporation in order to provide appropriate and tested crop production technological packages.
3. It is recommended that Technology Transfer and Extension Administration develops the scope of extension services, recruit more extension agents and provide continuous training for them to develop their capacities and increases their impact.

4. It is recommended that Technology Transfer and Extension Administration seeks to increases the rate of farmers' participation in planning, implementation, monitoring, and evaluation of extension programs.
5. It is recommended that Technology Transfer and Extension Administration adopts a extension systems, which are easy to follow and evaluate in order to ensure effective follow-up.

5-3-3 Recommendations for the Boards of administration of Agricultural Projects in Khartoum State

1. It is recommended that the Boards of Administration of the deferent agricultural projects administration to work on the increase their efforts to application of agricultural technologies recommended by the Technology Transfer and Extension Administration**.**

2. It is recommended that project administration to the farmers encouraged to increase more self-reliance as adult literacy programs.
3. It is recommended that project administration to encouraging farmers to participation in planning, operation, monitoring, and evaluation of extension program.
4. It is recommended that project administration to make more training programs in order to farmers to acquire abilities in the area of use of technology packages, managerial skills, holding of meetings, bookkeeping, accounting, marketing and storage.

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