# THE IMPORTANCE OF AGRICULTURAL INFRASTRUCTURE TO TRANSFORMATION TO ORGANIC FARMING IN LIBYA

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# DEDICATION

I would like to thank my parents, brothers and sisters for their invaluable support, inspiration and love.

No words can truly express my heartfelt appreciation to all of you who always have been proud of me anyway, and to all my friends with whom I spent this enjoyable time in my life.

# ABSTRACT

The importance of agricultural infrastructure to the development of organic farming in Libya is receiving considerable attention from policy makers in view of its potential in contributing to economic development. There is a vital role for agricultural infrastructure in promoting organic farming development in Libya. This would increase employment, enhance general economic development and stimulate growth in other sectors. Agricultural infrastructure already contributes to the general development of Libyan agriculture, and it may be vital to improving sustainability.

Despite growing research interest in agriculture in Libya, there is still work to be done to bring the relationship of infrastructure and organic farming development into focus. In order to understand better the role that infrastructure plays in the development of agriculture and transformation to organic farming. This research draws on agricultural development theory to enhance understanding on the relationship between agricultural infrastructure and transformation to organic farming in Libya. Particular attention is paid to the historical development of agriculture in Libya and the role politics played in shaping agricultural development and resultant policy initiatives.

The empirical focus of the research is on three main agricultural regions in Libya. This study argues that despite the fact that organic farming is in its embryonic stages in Libya, there is the potential to transform agricultural practices to facilitate organic farming if the constraints of availability and accessibility associated with current agricultural infrastructure especially at the regional and farm levels are given adequate attention with the involvement of all stakeholders including farmers. Interviews with ten agricultural experts provide a range of insights into the issues associated with infrastructure and agricultural development. A variety of issues and constraints which serve as barriers to agricultural development in Libya were identified from data collected from 277 farmers through questionnaires. The research highlights the importance of availability and accessibility of agricultural infrastructure to the transformation to organic farming in Libya. There is inadequate and inappropriate infrastructure especially at the farm level to promote the development of organic

farming practices. A variety of suggestions is presented on ways to improve the development of agriculture in Libya. This includes a suggestion for closer collaboration among all stakeholders in the agricultural sector so that the provision of agricultural infrastructure will be at the preferred areas to maximize their utilisation. This will require improved communication among all stakeholders in the planning and implementation of agricultural policies. The research highlights the importance of availability and accessibility of financial assistance to farmers as well as the provision of food processing plant.

The research shows that there is potential to enhance organic farming development in Libya and has demonstrated the importance of agricultural infrastructure to this process.

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## LIST OF ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| AOAD | Arab Organization of Agricultural Development |
| ARC | Agricultural Research Council |
| ARC | Agricultural Research Centre |
| ASRC | Animal Studies and Research Centre |
| CCOF | California Certified Organic Farmers Foundation |
| EGA | Environment General Authority |
| EU | European Union |
| GAI | General Authority of Information |
| GDP | Gross Domestic Product |
| GMMR | Great Man Made River |
| GPC | General Planning Council |
| GPCA | General People's Committee for Agriculture |
| GPCP | General People's Committee for Planning |
| GPCT | General People's Committee for Transport |
| IFPR | International Food Policy Research Institute |
| LYD | Libyan Dinar |
| MBRC | Marine Biology Research Centre |
| MOAN | Mediterranean Organic Agriculture Network |
| NA | Not Available |
| NARS | National Agriculture System |
| NASR | National Authority for Scientific Research |
| NES | National Economic Strategy |
| NFI | Net Farm Income |
| PCAAP | People's Committee for Agriculture and Animal Production |
| Sig. | Significance |
| SPSS | Statistical Package for Social Sciences |
| Std. | Standard |
| UN | United Nations |
| USAID | United States Agency for International Development |
| USDA | United States Department of Agriculture |
| WB | World Bank |
| WTO | World Trade Organisation |

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# CHAPTER ONE

## 1.0 Introduction

The development of agriculture in Libya has been the object of numerous studies. Some of these focus on the historic issue of Libya as a colony of Italy and the way that has affected the situation today. Joffé (1992), Plumbo (2003), and Del Boca (2003), for example, examine the influence of Italian colonial aspirations on the people and the economy of the Libyan State. Other writers such as Findlay (1994) have attempted to consider the broader Arabic world, its history and development, to take the perspective from that of a colonial past to the emergence as global powers through the impact of oil revenues. Much of this literature is written by Western academics looking in from outside. There is a wealth of Arabic literature on for example; the state of agriculture in Libya, but much of this is not easily accessible to non-Arabic speakers. Furthermore, in Libya in particular, the political isolation of the 1980s and 1990s has meant that much of this work was not subjected to independent academic scrutiny and it often failed to engage with wider intellectual developments occurring in the field around the world. The emergence of agricultural diversification in general and of organic food production in particular, is a case in point. Whilst other countries have witnessed increased organic production in parallel with the twin incentives or drivers of public concerns over health, and the possibilities for farmers of organic food as a premium, added-value commodity, Libya has lagged behind. Despite this, some agricultural commodities, such as camel and sheep meat, and herbs, dates and olives, which are produced in rural areas and in the desert regions, are considered as organic because of the way they are produced, without using chemicals. However, organic production in Libya, as in many countries in Africa, is rarely certified, and for many such countries new figures were not available (IFOAM, 2006).

The condition of organic production in Libya is supported by the finding of Parrott *et al.* (2005), who state that:

> ".....there are two levels of organic farming in Africa, certified organic production and non-certified or agro-ecological farming. Certified production is mostly geared to products destined for export beyond Africa's shores.

However, local markets for certified organic products are growing, especially in Egypt, South Africa, Uganda, Kenya and Tanzania."

A combination of political and economic isolation, of burgeoning oil revenues, and of a growing and urbanised population, has driven late twentieth-century Libya down the route of intensive industrial agriculture. Irrigation programmes and the use of inorganic fertilisers and pesticides have achieved this. Reclamation of arid lands has caused massive land degradation and irrigation threatens salinity problems. These issues are described in more detail later. However, whilst this thesis does not attempt to describe the history of Libyan agriculture in detail, some observations are worth noting as a matter of background and context. Libya was regarded as 'the bread basket of the Roman Empire' and early Mediterranean cultures exploited the agricultural riches of this North African landscape. The Greeks, Romans and others all came and exploited the region. This is in sharp contrast to the farming resource and landscape of today with a narrow Mediterranean belt and then the harsh, arid Sahara. It is suggested that a combination of over-exploitation of vulnerable soils and climate change have caused the dramatic transformation that we see today. This is described in detail by Keenan *et al.* (1976) and is discussed later.

In more recent times, Libya was governed and exploited by the Ottoman Empire from Turkey, and then by the Italian colonialists. The latter scenario is described in detail by Plumbo (2003) and Del Boca (2003), for example. Both these cultures sought to improve the economic and agricultural infrastructure of Libya in order to provide revenues to the Imperialists, an improved economy for the country of Libya, and so a ready market for capitalist produce from the host country (Turkey or Italy), to the colony (Libya). Their efforts went some way to begin the growth of modern Libyan agriculture with the provision of irrigation, of wells, of roads, and with the re-structuring of landscapes such as the terracing for fruit growing, now derelict in the Green Mountain region to the east of Libya. The Italians in particular, brought the necessary finance, the capital, in order to develop a more modern capital-based agriculture. However, despite these efforts, the overall impacts were limited and Del Boca (2003) describes the withdrawal or confiscation of Italian business capital. It is suggested therefore, that until the processes of intensification from the 1960s and 1970s, much of the agriculture that existed in Libya was inherently 'traditional' and low intensive, in effect, 'organic' farming. At the same time there was an increase in researcher interest in the potential of Libyan agriculture and in the necessary infrastructural improvements that were necessary (e.g. Atiga, 1970, 1972). This interest has continued (e.g. Shemeila,1976), and in recent years has included studies into the roles of infrastructure such as banking services and credit in relation to agricultural development (Ahmed, 2010). So far, there has been almost no attention paid to the potential for organic farming methods to be applied to the agriculture of Libya, and this is despite the growth of such approaches elsewhere in North Africa and around the Mediterranean. This situation and the gap in the knowledge base stimulated the idea for the present study. A starting point for the thesis is the role of agriculture more generally, and then to address issues of infrastructure and of organic farming specifically. The intention is to consider whether organic systems could be applied in Libya, and furthermore, whether the current and future infrastructures, might help or hinder such a transformation.

Agriculture plays an important role in the growth of economies over the world and it is the aim of governments to develop their agriculture sector in order to achieve food security. Over the last fifty years and sometimes longer, most countries have initiated policies to transform their agriculture sector to achieve faster economic growth and to produce more food. In this context, agricultural infrastructure has long been recognised as a strategic factor in agricultural development and economic growth. However, factors such as climate, availability of arable land, inputs such as seeds, chemical fertilizer, pesticides, farm management practices and government polices may constrain or trigger agricultural growth. The availability and accessibility of agricultural infrastructure and the efficient use of inputs are crucial to the development of agriculture. Agricultural infrastructure plays an essential role in agricultural transformation in terms of diversification and achieving food security. Ashok (2006) notes that significant investment in agricultural infrastructure would help increase production and consumption, decrease malnutrition and increase livelihood security.

This research explores the roles of agricultural infrastructure such as roads, and communication and information services, processing infrastructure, agricultural research and extension services, and credit and financial institutions. It considers how their availability and accessibility might influence the implementation of the principles of organic farming systems in the case study of Libya. The work examines the effects of agricultural infrastructure availability and accessibility on long-term soil fertility, use of manure and chemical fertilizers, use of pesticides and biological control, and the implementation of crop rotation practices.

The chapter introduces the importance of the research, establishes the research aims and objectives, the research question, and the theoretical or conceptual framework for the research. It gives an overview of the research methodological approach, which is discussed in detail in Chapter 4.

### 1.1 Theoretical Framework

Within developing countries, insufficient infrastructure is one of the key bottlenecks that limit the success in various sectors (African Development Forum, 2008). This is because it limits farmers' options and their agricultural outputs (Pinstrup-Andersen and Shimokawa, 2006). Yoshino and Nakahigashi (2000) indicate that the infrastructure of the farming industry is important, not only as a reflection of agricultural history and development, but also as an indicator for future diversification. It is therefore important to consider infrastructure within a clear conceptual framework.

Infrastructure is defined as the underlying foundation and basic framework of a system or organization that supports its functioning (McInerney, 1996). It is broadly accepted that there are different kinds of infrastructure. These can be described in general terms as economic infrastructure, social infrastructure, financial infrastructure, technological infrastructure, agricultural infrastructure. All these kinds of infrastructure are complementary to each other and are essential and integral parts of economic development (Venkatachalam, 2003). The World Development Report (1994) included the following in its definition of infrastructure:

(1) Public utilities: power, telecommunications, piped water supply, sanitation and sewerage, solid waste collection and disposal and piped gas.

(2) Public works: roads, major dam and canal works for irrigation and drainage.

(3) Other transport sectors: urban and inter-urban railways, urban transport, ports and waterways, and airports (World Bank, 1994).

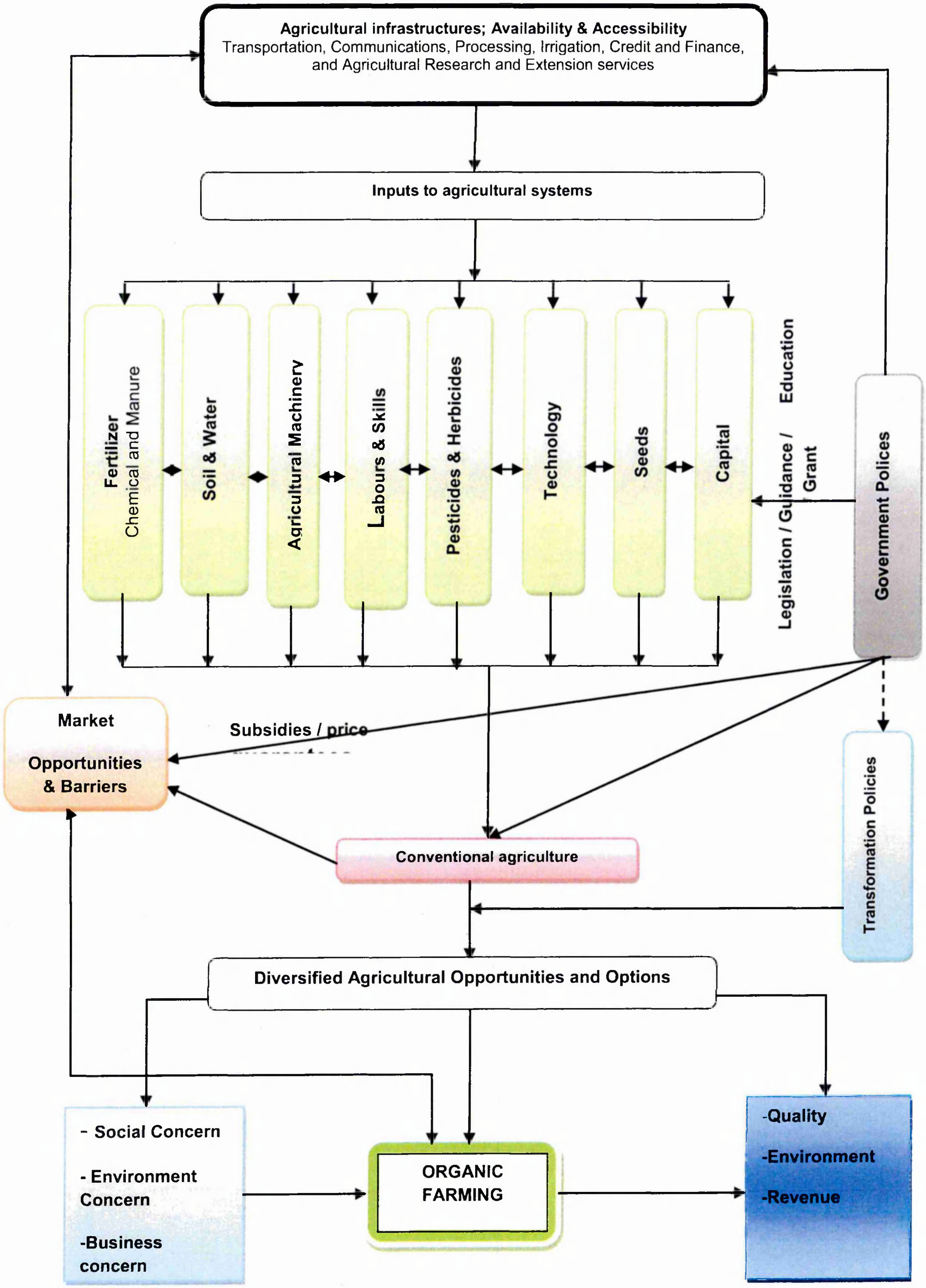
In another study, Ahmed and Donovan (1992) disagreed with this type of infrastructure definition. They suggested that the concept has evolved since the early work of Lewis and Hirschman (1958) towards a more comprehensive definition that includes a wider range of public services that facilitate production and trade. It is widely recognized that agricultural infrastructure includes all of the basic services, facilities, equipment and institutions needed for economic growth and efficient functioning of the food and fibre markets (Food and Agricultural Policy Magazine, *2003).* However, Fosu *et al.*, 1995, reflecting this broader definition, distinguish up to eleven components of agricultural infrastructure. These are:

1. Irrigation and public access to water
2. Transportation;
3. Storage services;
4. Commercial infrastructure;
5. Processing infrastructure;
6. Public services;
7. Agricultural research and extension services;
8. Communication and information services;
9. Land conversion services;
10. Credit and financial institutions;
11. Health and education services

The World Bank Report (1997) indicated the importance of infrastructure in agriculture and rural development. Agricultural infrastructure facilitates policy making and farmers' agricultural activities to take up certain normative measures to address key issues in agricultural activities (Venkatachalam, 2003). The successful stimulation of rural development through using fertilizer requires policies and programmes that ensure economically sound and technically efficient fertilizer use. Therefore, improved demand incentives require (1) better agronomic response, promoted by investment in the physical environment, technology research, and farmer training; (2) less volatile and higher (relative to input costs) output prices, promoted by public and private investment in market information, transportation, storage, and processing; and (3) lower fertilizer costs, promoted through improved transformation infrastructure.

Generally, infrastructure systems are inadequate in many economies of the Developing World. In many cases, the lack of available specialized inputs, capital markets, communication and transport systems, support services, irrigation and drainage can all limit diversification (Barghouti *et al.*, , 2004). In broad terms, agricultural systems seem to be affected by a range of different kinds of agricultural infrastructures (Venkatachalam, 2003). Figure 1.1 below, illustrates different kinds of infrastructure that affect agricultural systems in Libya and will form the theoretical or conceptual framework for the research.

**Figure 1.1 Research Conceptual Framework**




Source: Adopted by researcher.

## 1.2 Gaps in Current Research

There is a lack of information and limited awareness about agricultural infrastructure and organic farming approaches in Libya. In Libya, there are almost no published articles or empirical studies on the role of agricultural infrastructure in agricultural development. The same applies to organic farming despite the desire of some farmers to implement organic farming principles. The importance of organic farming is growing worldwide due to its positive impacts on the environment and human health and many countries are now adopting organic farming practices. This research focuses on the role of infrastructure in enhancing agricultural practices that lead to implementation to organic farming approaches in Libya. This research will explore the importance of infrastructure to transformation to organic farming and to what extent the availability of infrastructure can help transformation to organic farming in Libya. The outcome of the study will provide data for policy makers, research institutions, financial institutions and agricultural extension services to help develop the agricultural sector in Libya.

## 1.3 Aims

The primary aim of this research is to examine critically how infrastructure facilitates or hinders any transformation to organic farming in Libya. This is a particularly interesting and pertinent research since the country at present has no formally recognized organic farming sector. Additionally, Libya is affected by numerous problems associated with intensive agro-chemical use. This study aims to explore the importance of agricultural infrastructure to the development of agricultural sector in Libya.

## 1.4 Research Objectives

The aims of the research will be achieved through the following objectives:

1. To critically review relevant literature and other sources of information.
2. To evaluate the current situation in Libya as a case study of an emerging economy with very limited or no organic agriculture.
3. To examine the current levels and provision of agricultural infrastructure in Libya.

4. To explore the type of infrastructure needed to establish organic farming in Libya.
5. To explore the affect of current infrastructure on farming practices.
6. To assess the Libyan Government's policies and attitudes to the establishment of organic farming.
7. To evaluate the critical barriers that may influence the establishment of an organic farming system in Libya.

### 1.5 Research Questions

The development of agricultural systems depends mainly on the availability and accessibility of infrastructure. This research will focus on the roles of different kinds of infrastructure on development of the agricultural sector in Libya. In this study particular emphasis is given to the influence of infrastructure on potential transformation to organic farming systems in Libya. This research will address the key question:

*Does the successful development of organic farming in Libya depend on the adaptability of existing infrastructure?*

**The subsidiary research questions are:**

1. Do the current Libyan agricultural infrastructures meet the needs for the establishment of organic farming?
2. How should the supporting infrastructures develop in order to facilitate the growth of organic agriculture in Libya?
3. How does the process of conversion to organic farming in Libya relate specifically to peculiarities of farming in Libya?

Providing answers to these questions will help achieve the research aims and objectives.

In order to focus this research, six kinds of infrastructure were examined in detail and their impacts on agricultural systems will be assessed. These were chosen following an extensive review of relevant literature, and in-depth interviews with stakeholders in Libya. The selected areas are:

1. Transportation
2. Communication and information services
3. Processing infrastructure
4. Agricultural research and extension services
5. Irrigation and public access to water
6. Credit and financial institution
7. The key reasons for choosing the above infrastructure are:

1) These are the basic and important infrastructures for all agricultural systems;

2) These kinds of infrastructure are currently available in Libya; and

3) There is a need to assess whether they are appropriate for agricultural development and the transformation to organic farming.

### 1.6 Overview of Research Methodology

To achieve the aims and objectives of the research, a mixed-method approach was adopted in this research. The research methodology includes quantitative and qualitative research techniques. Following the analysis of the literature review, quantitative survey pilot studies were carried out on availability and accessibility of agricultural infrastructure and its role with agricultural practices and operations in Libya. Based on this, a questionnaire was developed and distributed to 600 farmers in three chosen agricultural regions in Libya. These were in the north-east in Aljafara, in the north-west in Algabal Al-Akdar, and in Fazzan in the south of Libya). Semi-structured interviews were also carried out with ten experts in organizations whose work relates to the agriculture sector and relevant to the topic of the research.

The three regions were chosen in order to make the samples representative of the overall diversity of Libyan agriculture. They include the main productive regions and areas of contrasting environmental and geographical constraints. The quantitative data gathered were analysed using the Statistical Package for Social Sciences (SPSS version 17). The qualitative data were analysed and interpreted manually.

A short study was also undertaken of organic farming performance in similar and neighbouring countries in order to provide a context for the potential transformation of farming in Libya.

### 1.7 The Study's Contribution to Knowledge

This research sets out to contribute to knowledge in the following ways:

- The research will build knowledge about agricultural infrastructure in Libya and its importance.
- Contribute to increasing the focus on the issues related to the level of the agricultural infrastructure and its effects on agriculture in Libya
- The research contributes to the process of developing an informed view on the required level of agricultural infrastructure to facilitate transformation to organic farming system in Libya.
- In addition, the research will contribute to raising awareness of technical problems that farmers face with the currently available infrastructure.
- The contribution value of this research will be in terms of lessons to be drawn for future agricultural development in Libya. This research may generate findings that are transferable to other developing countries.
- The research will contribute to knowledge on the role of agricultural infrastructure in Libya, and how it enhances agricultural practices such as the potential implementation of organic farming principles.

The research follows essentially a mixed methods approach that combines qualitative and quantitative studies. Findings from three geographically discrete sub-areas are combined, and information or data from farmers (by questionnaire survey), from expert stakeholders (by semi-structured interviews), and from an in-depth analysis of governmental and other reports (literature & document review), are triangulated in order to test the ideas and hypotheses of the research. An initial desktop scoping study was undertaken to identify critical issues and this was followed by interviews with senior government and research officers in order to sharpen the focus of the study. Finally, the questionnaire survey was tested with a short preliminary study and then modified according to the feedback received. There were opportunities to observe infrastructural issues first-hand during the implementation of the surveys. The detailed methodologies are described in full in Chapter 4.

## 1.8 Thesis outline

This section presents the structure of the thesis and gives a brief outline of each chapter of the thesis. These are as follows:

Chapter 2 gives the historical background about agriculture in Libya and the factors that affect the agricultural sector, such as climate, arable land and soil types and fertility, agricultural development in the country. It also focuses on the current agricultural infrastructure in the country. The agricultural regions selected for research are described in this chapter. The chapter also focuses on the reasons behind the desire for transformation to organic farming in Libya.

Chapter 3 presents literature on agricultural infrastructure and agricultural transformation. This covers the definition and concepts of agricultural infrastructure and agricultural transformation, the role of road transportation, communication and information services, of processing infrastructure, irrigation and public access to water, of agricultural research and extension services, and of credit and financial institution and markets.

Chapter 4 presents the research methodology. A mixed methodology was considered as the appropriate approach to achieve the research aims and objectives. The research methods and processes used are explained in detail. The chapter presents how data collection and analysis were undertaken.

Chapter 5 presents the analysis on the quantitative data analysis of the two hundred and seventy seven farmer's questionnaires from three agricultural regions in Libya

Chapter 6 presents the analysis on the qualitative data analysis of the ten interviews with, officials of the ministries including the Ministry of Agriculture and retired experts in the agricultural sector who belong to non-governmental organisations associated with agriculture.

Chapter 7 discusses the data presented in Chapter 5 and 6 in relation to literature examined in Chapters 2 and 3 and to the research aims and objectives.

The last chapter, Chapter 8, draws conclusions from the research and makes recommendations for the development of organic farming in Libya. It suggests areas for further research.

# CHAPTER TWO

## AGRICULTURE IN LIBYA

### 2.0 Introduction

This chapter examines the agriculture sector in Libya. The development of the sector depends on many factors such as natural resource availability, physical and social infrastructure and human resources development as well as capital and agricultural inputs. These factors have advantages and disadvantages that affect agricultural development in Libya. The objective of this chapter is to discuss the historical background of agricultural development in Libya and its current state and performance. It examines current agricultural infrastructure in Libya in terms of road transportation, communication and information services, processing facilities, irrigation and public access to water, agricultural research and extension services, and credit and financial institutions; and their effect on agricultural development. It also discusses the historical timeline for agricultural development in Libya from the Roman Empire through the Ottoman Empire, the Italian colonial era, the Kingdom era, the Republic era, and the Jamahiriya era. These different periods and historic influences affected agricultural policy and hence the development of the sector. This chapter is divided into eight sections, and each section presents relevant information on factors that play a significant role in agricultural development in the country. These sections are:

### 2.1 Topography and Climate

#### 2.1.1 Location

Geographically, Libya is located in the north of the African continent and has a Mediterranean coastline of 1,900 km (see Figure 2.1 below). The Mediterranean Sea forms the northern boundary. From this, the country extends 1,500 km in a southerly direction (Almahdowee, 1998). Libya's land area is around 1,750,000 square kilometres and borders six countries. These are Egypt and Sudan to the east, Tunisia and Algeria to the west, and Chad and Niger in the south (See Figure 2.1). Libya is 5.8% of the total land area of Africa. It is the fourth largest country in terms of size in Africa, and is ranked fifteenth globally in land area. In other words, Libya is larger than the combined areas of Germany, France and

Spain, and equivalent to seven times that of Britain as well equivalent to one third of the USA (Almahdowee, 1998).

Libya is divided into four geographical sections, as follows. Firstly, the coast extends along the Mediterranean coast along 1900 km by the Mediterranean Sea. Furthermore, the coast starts from Ras Alramalah in the north-east to Ras Agdir in the north-west through Sahl Aljafara to Sirte and to Tubruq. Secondly, there is a group of coastal plains which are distributed between the sea and northern highlands. The coastal plains are Sahal Aljafara, Sahal Sirt and Sahal Benghazi. Thirdly, there are the Northern Highlands, which consist of the Green Mountain in the north-east and the East Mountain; these are considered to be the highest areas in the north-east, and they descend from the north to the south towards the coastal plain. Lastly, the Sahara territory stretches from the Northern Highlands to the far south( see figure2.1). Many oases such as Ghadames and Giagabub are found in this area. Almost 95% (72.2 million hectares) of the space in Libya is desert, while the cultivable area is limited to 3.80 million hectares (Almahdowee, 1998).

### 2.1.2 Climate

The climate of Libya is mainly affected by Mediterranean conditions in the north and a dry desert climate in the middle and the south. This gives the country a unique climatic mix consisting of a blend of desert and maritime climates. Along the coast of the Mediterranean Sea, summers are hot and dry with average temperatures around 30°C, while winters are mild and with occasional rains (Shrf, 1996; Almahdowee, 1998). During the spring, warm and dry winds cause sudden rises in temperature. The Libyan Desert is the driest and harshest desert in the world. It has a wide temperature range over day and night, and a wider range between summer and winter. The temperature exceeds 50°C during the day in the summer, while it drops below 0°C in the winter at night. In general, the dry desert climate prevails in the country with the exception of only a narrow strip that extends along the Mediterranean where the most important cities are located and some mountainous spots in the north and the south (Shrf, 1996). In these areas the climate is moderate, receiving rainfall in the winter that helps with the growth of some plants. Indeed, in areas such as Algabal Al-

Akdar the rainfall is enough for the growth of forests and vegetation cover similar to that prevailing in other parts of the Mediterranean region.

### 2.1.3 Land and Rainfall

The total arable land of the country is around 2% (2.2 million hectares) of the land while only 4% of the land area of Libya is suitable for grazing. The utilisation of the 2.2 million hectares of arable land is critical, as the distributions of rainfall and soil fertility are uneven throughout the country (Porter, Yergin, 2006).

Most of this land is close to the coast, and the main agricultural areas include Algabal Al-Akdar and Cyrenaica in the east of the country, and Jabal Nafusah and Aljafara Plains around Tripoli.

Libya's soil is mainly sandy, shallow and coarse with limited natural fertility. Sandy soils in the country are severely exposed to wind erosion, affecting their fertility and hence agricultural production. Salinity and sodality constitute major problems in the north, mainly due to irrigation over a long time by water contaminated by the sea and poor drainage. As a result, substantial soil degradation is taking place in the country.

It has been reported that soil salinity problem has affected 190,000 hectares of land in Libya due to poor irrigation and drainage practices. This was confirmed in 1998, by the UN Food and Agriculture Organization (FAO) according to Laytimi( 2006).

Rainfall is not sufficient for agricultural purposes and needs to be supplemented with irrigation. Today, 309,000 hectares are currently under irrigation, mainly through groundwater extraction, which now far exceeds replenishment in these coastal areas, and is resulting in groundwater depletion (Porter, Yergin, 2006).

The estimated annual rate of rainfall in the northern regions is between 200-600mm. During the winter, thunderstorms and rainstorms occur particularly in the mountainous regions in the west and the east (Aljandeal, 1978). In general, the rainy area of Libya consists of about 7% of the country and the number of rainy days is between 30-90 days in these areas (Aljandeal, 1978). The specific classification of soil and rainfall distribution in Libya is illustrated in Table 2.1.

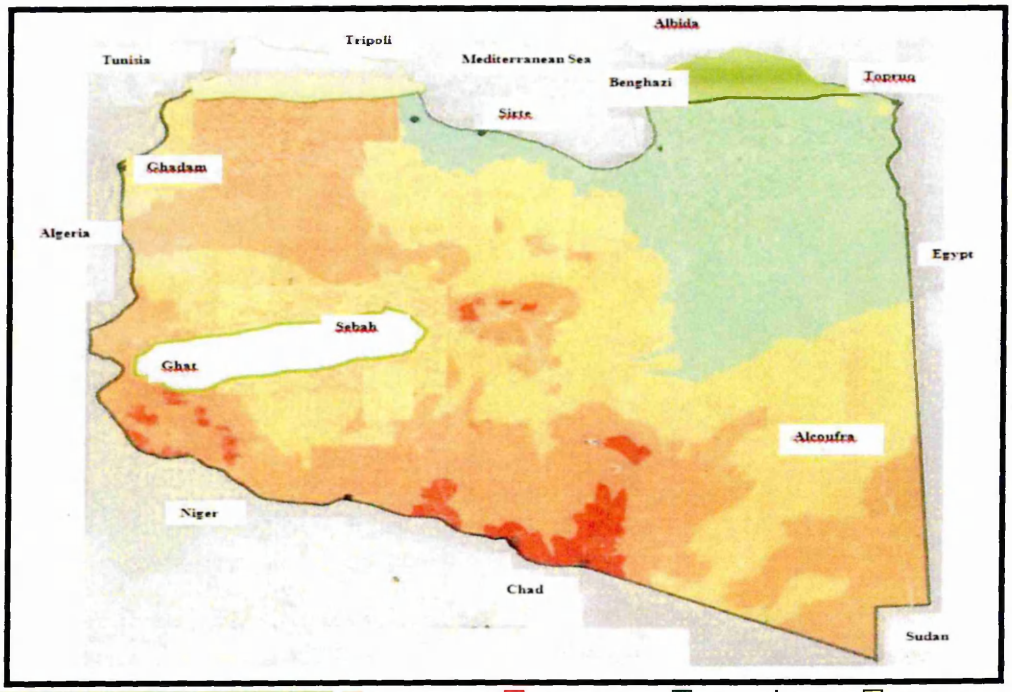
## 2.2 Population Distribution

The distribution of the population in Libya is highly affected by the climate. The population is concentrated mainly in the north where the moderate climate of the Mediterranean prevails. The population density in these areas reaches 50 people/km², while it falls to less than one person/km² in the southern desert areas. Overall, 90% of the people in Libya are living on less than 10% of the land, primarily along the coast. About 88% of the population are urban and mostly concentrated in the two largest cities, Tripoli and Benghazi (Sarf, 1996).

## 2.3 Study Regions

The research focuses on the three main agricultural regions in Libya: the Algabal Al-Akdar region in the north east; the Aljafara region in the north-west; and the Fazzan region in the south. These regions also represent a wide range of geographical areas with different topography and a variety of agricultural products. Figure 2.1 below illustrates the Libya location and the three study areas. It also clarified the coastal zone and the high lands and the Sahara territory as well as the mountains which contains northern east mountains and the south mountain. Furthermore, a brief description of agricultural regions is given in the next section.

Figure 2.1 Libyan Map Showing Agricultural Regions




ALGABAL AL-KDAR REGION
ALJNAFARA REGION
FAZZAN REGION

Highlands Mountains coastal zone Sahara

Source: adopted from Shrf (1996) and the researcher (2011)

### 2.3.1 Algabal Al-kdar Region

The Algabal Al-kdar region is located in the north-east of Libya and stretches from Benghazi in the west to Darna in the east with the Mediterranean Sea in the north. The region covers about 884,923,000 hectares. The region includes the high ground of the Green Mountain, which rises to 250-880m above sea level. The population in the region is about 525,000 people (Porter, Yergin, 2006).

There are many valleys across the region such as the Darna Valley, which is about 75km long. The climate of the region is considered cold in the winter and moderate in the summer. Rainfall is the most important water resource in the region and it registers the highest annual rate of the rainfall in the whole country. Therefore, the agricultural activities in this region are dependent on the rainfall. The region has various soil types according to USA soil classification standards: Entisole, Aridisols, Alfisols, Mollisols, Vertisols, Inceptisols and Calcareous (Ben Mohmod, 2000).

The Algabal Al-kdar region is the most important region in Libya for barley and wheat production. It provides about 43% of the total area of wheat cultivation in the country, yielding about 49.5% of the total wheat production. Furthermore, it accounts for 57.5% of the total area of barley production in the country. Fruits such as apples, pears, peaches, almonds and grapes, as well as vegetables, are the most important agricultural products in the region (Almahdowee, 1998). Figure 2.2 illustrates the landscape of the Algabal Al-kdar region. Mixed farming is considered one of the characteristics of farms in the region (see Figure 2.3).

**Figure 2.2 Landscape of farming in Algabal Al-kdar**

**Figure 2.3 Mixed Framing in Algabal Al-kdar**

### 2.3.2 The Aljafara Region

This region is located between the Tunisian border in the west to Ras Almasn from the north of Alkoums City and the Mediterranean Sea in the north, and Nafosa Mountain in the south. The total area of arable land in the region is about 500,000 hectares. Cereals, dates, vegetables, grapes, orange and olives are the most significant agricultural products. Agriculture in this region is dependent on rainfall and underground water, and the latter also receives water from the Great Manmade River. This region has both the most agricultural activity and the highest population in the country. The region has several types of soils: Entisole, Aridisols and Inceptisols (Ben Mohmod, 2000). Figure 2.4 shows the landscape of the Aljafara Region, while. Figure 2.5 shows an olive tree farm, as olives are one of the most important crops produced in the region.

Figure 2.4 Farming Landscape in Aljafara Region

Figure 2.5 Olive Farm in Aljafara Region

### 2.3.3 The Fazzan Region

The Fazzan region is located in the south of the country. It extends from the Algerian border in the south-west to Alhamda Alhmra in the north and to Chad and Niger in the south. The total arable area is about 26,735 hectares. Agriculture in the region is dependent on underground water. Soil types in the region are Entisole, Aridisols and Inceptisols (Ben Mohmod, 2000). The most important agricultural products produced in this region are dates, cereals and vegetables. Figure 2.6 shows the Fazzan region landscape and Figure 2.7 shows a date palm farm, as it is the most important type of farm in the region.

**Figure 2.6 Fazzan Region Landscape**

**Figure 2.7 Date Palms Farm In Fazzan Region**

Table 2.1 below summarises the agricultural characteristics of the selected regions in terms of altitude, average annual rainfall, soil types, sources of energy and water, and major crops produced.

**Table 2.1 Agricultural Characteristics of the Three Agricultural Regions in Libya**

| Region | Altitude (Metres Above Sea Level) | Average Rainfall (mm) | Soil Type | Source Of Water Supply | Major Crops |
|---|---|---|---|---|---|
| Algabal Al-kdar | 416 | 350-600 | Entisole<br>Aridisols<br>Alfisols<br>Mollisols<br>Vertisols<br>Inceptisols<br>Calcareous | Rainfall and Wells | Barley, Wheat Vegetables, Grapes and Apples |
| Aljafara | 17 | 350-500 | Entisole<br>Aridisols<br>Inceptisols | Rainfall and Wells | Barley, Wheat, Oranges, Dates and Olives |
| Fazzan | 445 | 8.5 | Entisole<br>Aridisols<br>Inceptisols | Wells | Barley, Vegetables, Wheat and Dates. |

Sources: Ben Mohmod (2000) and Aljandeal (1978)

## 2.4 Historical Background of Agriculture in Libya

This section presents a brief history of agriculture in Libya. It is broadly divided into five phases: the Roman Empire; the Ottoman Empire; the Italian colonisation; the Libyan Kingdom; and finally the Alfatah revolution or Jamahiriya. A review of Libyan agriculture history helps to understand the research context better; it helps explain the current state of farming from its development.

Pastoral agriculture was the main activity for the majority of the population in Libya until the advent of oil. Numerous excavations and archaeological studies show Libyans were engaged in settled agricultural activities. They used ploughs and harvesting tools to cultivate the land and extracted water from groundwater wells (Almahdowee, 1998). Agriculture plays an important role in the growth of economies around the world and it is the aim of governments to develop their agriculture sector in order to achieve food security. The agriculture sector has been the subject of successive policies in order to contribute more effectively to the GDP (Porter & Yergin, 2006). However, despite the difficulty with the study of Agricultural History of Libya due to the lack of information, the researcher highlights some points of agricultural history of Libya with regard to some phases. However, the greatest difficulty with the study of Libyan agricultural history was during the mediaeval period.

### 2.4.1 Agriculture in the Neolithic Era

"Environmental evidence, as well as rock painting and archaeological remains all point to much more moist conditions than today. Many large game animals, which presently only occur in the savannah to the south of Sahara (e.g. elephant, giraffe, hippopotamus, and crocodile), are known to have lived in what is now desert" (Roberts, 1989; Muzzolini, 1989, 1993; Phillipson, 1993 cited in Van Der Veen, 1995). Fishing was practised in that era, which is an indication that there was sufficient water in the Sahara at that time to allow fishing as a subsistence activity (Van Der Veen, 1995 in Stahl, 2005).

There is also evidence that livestock management has long been practised in Libya (See Barich, 1992; Gautier, 1987; Muzzolini, 1989, 1993 in Stahl, 2005). Mixed Mediterranean-style farming which included the management of livestock was practised during the Roman and post-Roman era in the arid hinterlands of the southern Mediterranean shores (Van Der Veen, 1995, Grant & Barker, 1996 in Stahl, 2005). Romano-Libyan livestock farmers were nomads who practised uncontrolled grazing which it is believed resulted in the widespread destruction of desert vegetation(in Stahl, 2005).

This assertion is supported by (Barich, 1987; Barker, 1981 in Stahl, 2005), who argued that animal herding and Saharan subsistence strategies that took place at the time contributed to the onset of the process to drought and the present-day Saharan environment that was finally established by about 2000 BC (Shaw, 1976 in Stahl, 2005).

However, agricultural strategies and the introduction of livestock management into Saharan subsistence strategies in the late fifth millennium ensured an efficient use of dispersed seasonal grazing and water and regular supply of milk and meat.

### 2.4.2 Agriculture in the Roman Era

It was found that in the later 1$^{st}$ Century CE, Romano-Libyan farmsteads were open farms (Barker & Jones, 1984; and Barker & Gilbertson, in 1996 in Hunt, *et al.,* 2001). The farming practices during the era were based on networks of floodwater farming-based systems, which produced cash crops of olive oil and cereals for export to the Roman Empire through the port cities of Tripolitania-Oea (Tripoli), Sabrath and Leptis Major (Mattingly, 1996, in Hunt, *et al.,* 2001).

Large fortified farmhouses called "Gsur" dominated the settlements from the 3rd century. These farmhouses continued after the end of the Romano-Libyan period (5$^{th}$ century CE), during the Byzantine (5$^{th}$-8$^{th}$ centuries CE) and Arab periods 8$^{th}$-17$^{th}$ centuries CE) (Barker *et al.*, 1996a, 1996b; Gilbertson, Hunt & Gillmore, 2000 in Hunt *et al.,* 2001).

### 2.4.3 Agriculture in Mediaeval Era (Moors Era)

The mediaeval period was between the Roman and Ottoman ones. Brett (1989 in Mattingly & Lloyd, 1989) states that there was no such thing as mediaeval Libya, despite its desert area and scattered centres of population. However, the available information about history of agriculture in mediaeval era is very limited.

### 2.4.4 Agriculture in Libya: The Ottoman Era

During the Ottoman era in Libya, income from agricultural sources was greatly increased through the imposition by the state of a number of taxes (Touer, 1991). During this period, agriculture was considered the most important economic resource, following the deterioration of the caravan trade across the desert. This was for a variety of reasons such as insecurity in the country and the takeover of Algeria in 1830 and Tunis in 1881 by France, and the takeover of Egypt in 1882 by Britain. These led to decreases in active trade routes between Central Africa and the Mediterranean Sea through the Libyan territories (Akad, 1991).

The Ottoman era was characterised by abundant groundwater and annual rainfall in winter and spring (Touer, 1991). However, agriculture depended on irrigation from water wells and springs, which were few in number. Livestock was a significant source of economic life in the country, where the camels, cows, donkeys and horses were the most important animals and were used in agricultural activities. The Ottoman Empire introduced several new crops to Libya. These crops were potatoes, coffee, sesame, cotton, oranges, berries and some forest trees such as pine and willow. Agricultural activities also focused on palm trees, olives, almonds, figs, grapes and barley (Touer, 1991). The most important summer crops were tomatoes, melons, corn and millet in addition to fruit trees such as palms and olives, grapes, figs, apricots, apples, oranges, lemons, pomegranates and peaches (Touer, 1991).

The Ottoman government focused on forest development and planted tens of thousands of trees. For example, they imported about 20,000 willow tree seedlings from Izmir, Turkey to plant in various parts of Libya; these were exploited later in the building of telephone lines. The main purpose of planting forest trees was to protect the environment from soil and other forms of erosion (Touer, 1991).

The Ottoman state also advanced agriculture by issuing the law of Tabo Ottoman in 1858. This law registered the farmers and other citizens of their land. This was to avoid the occurrence of bloody conflicts between individuals and tribes (Ben-Esmail, 1966). However, agriculture in the period of Ottoman rule also faced difficulties and obstacles such as a number of high taxes, the spread of ignorance, disease and lack of knowledge of modern agricultural matters, combined with agricultural pest resistance. There were problems with insects like locusts, and for animals, parasitic worms, and there was a lack of veterinarians to treat them (Touer, 1991).

### 2.4.5 Agriculture in the Italian Era

After the occupation of Libya by Italy in 1911, the Italian government displaced Libyans from their lands and distributed the land to Italian families for the purpose of agriculture (Marten, 1989). The Italian government conducted comprehensive survey studies of the sources of groundwater and drilled some of the artesian wells in Libya. They also set up factories to manufacture olive oil, wine and tomatoes (Marten, 1989). They used improved seeds and organic fertilizers in the farms and planted olive trees in the seized territories. Using modern scientific methods, wheat sugar beet, potatoes, citrus, almonds, grapes and olives were the most important agricultural crops. The Italian government conducted the first agricultural census in April 1937. The census results reported that agricultural progress was slow. Some Italian banks were established to fund Italian farmers to develop their farms (Almahdowee, 1998).

### 2.4.6 Agriculture in the Kingdom of Libya

At the beginning of the 1950s, about 80% of the population of Libya lived in rural areas and depended on agriculture for their livelihood. The livestock at that time consisted of cattle, sheep, goats, donkeys, camels and horses (Atir *et al.*, 1981). Due to economic poverty, Libya did not develop its agriculture in the 1950s and did not witness any development programmes. The public sector did not intervene and left agricultural activities to individual effort, which traditionally used small pieces of land and depended on manual labour, with the exception of large farms in Tripoli, which were owned by Italians (Atir *et al.*, 1981).

The results of the 1960 agricultural census show that the average monthly income in the agricultural sector was Libyan £19 while the average per capita income outside agriculture was almost double this amount. This led to the decline in agriculture due to many farmers migrating from agriculture to work in other sectors (Atir *et al.*, 1981). However, the money accumulated from the discovery of oil, as well as technical assistance provided by the government, contributed to an improvement in agricultural production in the 1960s. The development of the agriculture sector increased during the period 1962-1967 at an annual rate equivalent to 4.5%. This was much lower than the rates of growth in the economy and much less than the rise in demand for food: domestic production in 1967 only covered 5% of the total food requirements (Attiga, 1970).

Nevertheless, the agricultural sector at that time was not developed due to the limitations of the economy which was considered as the poorest economy due the limitation of funding. Therefore, the development of agriculture in Libya can be divided into two sections according to the economic situation; namely, agriculture before the discovery of oil and afterwards. The former includes the development of agriculture during the Roman ea, Italian era and Libyan kingdom. The latter, on the other hand, refers to the real changes in the development of agriculture, which happened after the discovery of oil in Libya. Therefore, since 1970, the agriculture sector has been developed. This development began during the Alfatah revolution era, and this is addressed in detail in the section in this thesis on Agriculture in the Jamahiriya Era.

However, before the discovery of oil, the Libyan economy was considered primitive: average income per capita did not exceed LYD12, equivalent to £24 in 1952. Most of the population was involved in the agriculture sector: farming was their sole source of livelihood and they made only a subsistence living (Bruon, 1971). Agriculture was marginal and lacked financial capabilities and scientific methods due to the poor financial resources of the farmers and their widespread ignorance of modern farming practices. The lack of advanced techniques and modern equipment together with insufficient water resources led to poor agricultural activity. All these factors led to limited cultivated areas; the population in such areas dispersed and became concentrated in the more fertile coastal regions. In addition, there was an increased migration from the rural areas to the main cities (Bruon, 1971). Then immediately after the discovery of oil in the 1950s, the Libyan economy started to recover.

### 2.4.7 Agriculture in the Jamahiriya Era

During the Jamahiriya era, the state became very interested in agricultural development and prepared a plan for this. Basically the development of the agricultural sector became a reality after the start of the implementation of three development plans from 1973-1985 and annual plans built on the various programmes which were aimed at increasing production rates of different agricultural crops in order to achieve self-sufficiency. Increasing the production of grains such barley and wheat, vegetables and fruits to achieve self-sufficiency are the most important aims of agricultural development in Libya (Al-Gamatee, 2000), and farming has been developed by using modern technologies such as irrigation systems.

The development of the grazed pastures sector was one of the agricultural development programmes in that period of time. Therefore, thousands of hectares of quality pasture were established and several wells were drilled, in addition to improved seeds being produced. The Transformation Plan (1976-1980) was aimed at the development of livestock, especially cattle, sheep, goats and camels, and created many projects related to the development of animal husbandry (Almahdowee, 1998).

### 2.5 Agricultural Development During the Jamahiriya Era

The actual change in the economy occurred when the country started producing and exporting oil, and the economic recovery emerged through the considerable increase in the annual budget from 13,331 million dinars in 1955/1956 to 13,453 million dinars in 1965/1966. The average income per capita grew to 488 dinars in 1968. Despite the increase in the annual budget, however, the agricultural sector deteriorated during this period due to the shrinking of agricultural lands surrounding the cities. This led to the disappearance of whole farms because of the trend of creeping urbanization. Many farmers had migrated to cities to work in oil companies for higher wages. The deterioration of the agricultural sector caused high food prices and a large volume of imports of agricultural products from abroad (Almahdowee, 1998). The introduction of diesel-fuelled machinery initially improved agricultural production but factors such as the scarcity of markets, poor transportation and lack of trained technicians to repair the machinery subsequently led to a significant drop in agricultural production.

After the Revolution in 1969 (Al-Gamatee, 2000) the political leadership headed towards the liberalization of the Libyan economy from dependency and reliance on others and encouraged developing local capabilities in order to ensure food safety. Attention focused on the agricultural sector to be a viable alternative to oil. The government focused on implementing economic and social development in three phases:

Phase 1: The triennium transition plan (1973-1975).
Phase 2: The first five-year transition plan (1976-1980).
Phase 3: The second five-year transition plan (1981-1985).

Since these phases, the development of the various sectors of the economy including agriculture has depended on the achievement of annual plans with determined goals and objectives for specific requirements. The basic development of agricultural infrastructure was part of these comprehensive plans. The purpose of these plans was to raise the standard of living of the citizens, accelerate the Libyan economy and take advantage of all the natural resources of the country towards self-sufficiency in agricultural production. Large amounts of money were allocated to achieve this transformation.

Table 2.2 below shows the budgets allocated for the agricultural sector and the actual expenditures for agricultural investment, the agriculture sector contribution to the GDP, and agricultural labour forces between1970 and 2007.

**Table 2.2 Oil Revenue and Budgets Allocated for the Agriculture Sector, 1970 - 2007**

| Year | Oil Revenue | Sector Allocation Million LYD | Actual Expenditures (Agricultural Investment) Million LYD | Total GDP | Agricultural GDP/Million LYD | Agricultural Labour Force/000 | Total Agricultural Granted Loans / Million LYD |
|---|---|---|---|---|---|---|---|
| 1970 | 841.1 | 48.20 | 23.60 | 1,288.3 | 33.1 | 126.00 | 5.920 |
| 1980 | 6,486.4 | 448.10 | 489.90 | 10,553.8 | 236.4 | 153.40 | 5.112 |
| 1990 | 3,744.9 | 360.00 | 217.80 | 8,246.9 | 482.9 | 188.90 | 19.045 |
| 2000 | 5,221.5 | 172.40 | 141.20 | 17,775.4 | 1,437.7 | 232.20 | 37.400 |
| 2005 | 31,148.0 | 427,40 | 367.30 | 43,561.0 | 1,447.5 | 242.50 | 375.364 |
| 2007 | 40,972.1 | 322.09 | 330.14 | 48,709.2 | 1,905.0 | 248.50 | 242.300 |
| TOTAL | 250,844.6 | 8,830.99 | 7,119.24 | 49,2307.5 | 25,450.9 | 7,090.91 | 1,960.166 |

Source: GPCA (2009).

Table 2.2 shows that the Libyan government invested heavily in the development of the agricultural sector from 1970 to 2007. The total amount of money allocated for agricultural development was about 48.2m LYD in 1970, which increased to 322.09m LYD in 2007. Table 2.2 also indicates that the agricultural sector contributed hugely to the GDP over the same period. It contributed 33.1m LYD in 1970, and this increased to 1,905.0m LYD in 2007. In comparison, revenue from oil was 841.1m LYD in 1970, and then increased to 40,972.1m LYD by 2007. The table also shows that the labour forces in the agricultural sector had increased from 126,000 in 1970 to 248,500 in 2007. This reflects the growth of the agricultural sector in Libya. Furthermore, agricultural loans increased from 5.92m LYD in 1970 to 242.3m LYD in 2007. These increases indicate the development in the agricultural sector, which encouraged farmers with the introduction of new technologies and assisted them with agricultural inputs.

The production depends on both the private and the state sector, the latter being the predominant producer of grains (Al-Idrissi *et al.,* 1996). Most of the territories in Libya are dry. Therefore, irrigated farms and irrigation systems are of crucial importance in extending the area available for farming and increasing the country's overall agricultural output. Currently 50% of the cereal production and about 90% of the fruit and vegetable production come from irrigated farms (AOAD 2009); this emphasises the role of irrigation in increasing agricultural production.

The agriculture calendar in Libya is seasonal, and virtually all crops are grown for local consumption. Olive oil, fruit trees and citrus and fodder are considering as permanent crops which consists of about 52% permanent crops. The other annual crops such as wheat, barley, vegetables, potatoes, pulses and others which account 48% of irrigated cropping pattern (Porter & Yergin, 2006).

Since 1970, the agricultural sector in Libya has developed and modernised significantly. Agricultural production is affected by many factors such as climate, water, soil, agricultural inputs, machinery and equipment, farmers' experience, capital resources, cultivated areas, government plans and policies, and agricultural infrastructure such as roads, communication and information services, processing infrastructure, irrigation and public access to water, agricultural research and extension services, and credit and financial institutions. Therefore, the availability and effectiveness of these factors leads to an increase in agricultural production.

However, agriculture in Libya faces many challenges, which directly affect production. These include the low fertility of soils and irrigation problems. Libyan agriculture depends on four sources of water: underground water, rainfall water, recycled sewage water, and desalination water. The availability of water is the most important factor for agricultural production development.

Table 2.3 illustrates the trend of agricultural production in Libya from 1986-2005 according to four classes: plant production, animal production, fish production and forest production.

**Table 2.3 Agricultural Classification Development, 1986 - 2005 by Libyan Dinar**

| Years | Total Agricultural Production By Million LYD | Plant Production (%) | Animal Productio (%) | Fish Production (%) | Forest Producti (%) |
|---|---|---|---|---|---|
| 1986 | 384.70 | 81.70 | 17.80 | 0.13 | 0.36 |
| 1990 | 482.90 | 58.64 | 39.53 | 1.47 | 0.35 |
| 1995 | 933.40 | 61.38 | 34.95 | 2.99 | 0.66 |
| 2000 | 1,437.70 | 55.64 | 41.38 | 2.34 | 0.63 |
| 2005 | 1,541.00 | 52.24 | 44.32 | 2.92 | 0.52 |

Source: GPCP, 2006.

Table 2.3 shows that Libyan total agricultural production increased from 384.7 million Libyan Dinars in 1986 to 1,541 million Libyan Dinars in 2005. Plant production was 81.70% of total agricultural production in 1986. It decreased to 58.64% in 1990, increased to 61.38% in 1995, and then decreased again in 2000 (55.64%) and in 2005 (52.24%). Animal production rose from 17.80% in 1986 to 39.53% in 1990, but then fell in 1995 to 34.95%. In 2000, it rose again to 41.38% and continued rising to reach 44.32% in 2005.

The figures show that fish production increased gradually from 0.13% in 1986 to 1.47% in 1990, climbing to 2.99% in 1995. In 2000, it decreased to 2.34% then increased again to 2.92% in 2005. Forest production accounted for 0.36% of total agricultural production in 1986 then fell slightly to 0.35% in 1990. It rose to 0.66% in 1995, but fell to 0.63% in 2000, and then went down further to 0.52% in 2005. It is important to focus on the development of each agricultural commodity to understand the trend of the government's policies and plans and farmers' directions on how to provide these commodities.

**Table 2.4 Agricultural Commodities Development by LYD/Million Dinar, 1970- 2007**

| Type Of Production | 1970 | 1975 | 1980 | 1985 | 1990 | 1995 | 2000 | 2005 | 2007 |
|---|---|---|---|---|---|---|---|---|---|
| Wheat | 27.2 | 75.1 | 140.5 | 210.0 | 128.0 | 23.0 | 64.0 | 125.4 | 104.0 |
| Barley | 52.8 | 191.8 | 71.0 | 105.0 | 134.0 | 117.0 | 264.0 | 250.0 | 24.0 |
| Maize | 1.3 | 1.2 | 1.1 | 1.2 | 0.53 | 0.4 | 2.0 | 1.5 | 1.5 |
| Legumes | 13.7 | 21.1 | 12.6 | 18.0 | 27.0 | 52.0 | 30.0 | 31.5 | 35.0 |
| Vegetables | 205.2 | 562.3 | 667.6 | 877.5 | 921.0 | 1183.0 | 1226.0 | 1254.0 | 1260.0 |
| Olives | 69.2 | 150.4 | 161.0 | 144.0 | 147.0 | 168.8 | 150.0 | 180.0 | 180.0 |
| Fruits | 90.3 | 130.4 | 187.5 | 280.6 | 377.0 | 599.5 | 650.0 | 367.0 | 386.0 |
| Red Meat | 42.3 | 57.70 | 58.6 | 94.8 | 154.5 | 163.3 | 170.0 | 183.0 | 189.0 |
| Milk/M Litre | 52.4 | 86.60 | 99.1 | 150.5 | 210.0 | 220.0 | 270.0 | 410.0 | 310.0 |
| Eggs/M Egg | 45.4 | 160.0 | 285.4 | 554.0 | 675.0 | 800.0 | 860.0 | 932.0 | 900.0 |
| Honey/Tonne | 30.0 | 235.0 | 360.0 | 500.0 | 675.0 | 837.0 | 720.0 | 800.0 | 800.0 |
| Fishes | 19.6 | 48.03 | 52.0 | 21.70 | 28.4 | 25.8 | 34.6 | 27.1 | 20.0 |
| Chicken Meat | 1.8 | 18.0 | 27.0 | 25.0 | 68.6 | 102.0 | 104.0 | 186.6 | 93.0 |

Source: (Shalloof *et al.*, 2009)

Table 2.4 shows that agricultural commodity development is increasing in terms of value over the years. Most of the commodities have witnessed a sharp increase, specifically since 1990. This was especially the case in the production of fruits, eggs, honey and chicken, and is due to demographic changes and the development of the agriculture sector in general.

**Table 2.5 Agricultural Commodities Developments in Metric Tonnes, 1970 - 2007**

| Type of Production | 1970 | 1975 | 1980 | 1985 | 1990 | 1995 | 2000 | 2005 | 2007 |
|---|---|---|---|---|---|---|---|---|---|
| **Wheat** | 109.5 | 143.0 | 410.0 | 351.2 | 508.0 | 360.0 | 1881.9 | 1528.2 | 1142.6 |
| **Barley** | 332.1 | 429.7 | 238.9 | 495.0 | 1004.0 | 879.8 | 301.8 | 38.0 | 312.4 |
| **Maize** | 35.3 | 146.2 | 74.8 | 127.2 | 285.5 | 18.6 | 278.6 | 520.7 | 315.3 |
| **Vegetables** | 217.6 | 576.7 | 668.2 | 877.5 | 1131.0 | 1253.7 | 1295.8 | 1285.8 | 1291.8 |
| **Fruits** | 155.3 | 192.4 | 189.5 | 288.6 | 404.7 | 619.0 | 667.4 | 424.9 | 443.4 |
| **Meat** | 72.8 | 108.3 | 129.0 | 118.0 | 210.5 | 169.1 | 173.6 | 227.0 | 209.5 |
| **Eggs** | 45.5 | 160.1 | 285.5 | 555.8 | 676.7 | 801.6 | 860.8 | 935.9 | 905.3 |
| **Milk** | 73.9 | 420.6 | 425.1 | 619.1 | 585.0 | 580.6 | 550.2 | 646.4 | 873.9 |

Source: (Shalloof *et al.*, 2009)

Table 2.5 shows that most of the agricultural commodities sharply increase in quantity, especially after the year 1990. This is probably due to increased market demand and consumption.

### 2.5.1 Agricultural Sector Contribution to GDP

Agriculture has a marginal contribution of 9% to the Gross Domestic Product (GDP) of Libya. The sector employs 5% of the total economically active population (FAO, 2005a). Rising figures of contribution to the GDP is a reflection of the importance of the agriculture sector in the economy.

**Table 2.6 Agricultural Sector Contribution to GDP**

| Years | Total GDP | Agricultural GDP | Contribution of agricultural GDP to total GDP | Population | Agricultural loans granted |
|---|---|---|---|---|---|
| 1970 | 1,288.3 | 33.1 | 2.5 | 2,006.00 | 5.920 |
| 1975 | 3,674.3 | 82.9 | 2.3 | 2,683.20 | 8.923 |
| 1980 | 10,553.8 | 236.4 | 2.2 | 3,197.00 | 5.112 |
| 1985 | 7,852.1 | 342.2 | 4.4 | 3,618.40 | 10.303 |
| 1990 | 8,246.9 | 482.9 | 5.8 | 4,150.00 | 19.45 |
| 1995 | 10,672.3 | 933.4 | 8.7 | 4,799.00 | 18.155 |
| 2000 | 17,775.4 | 1,437.7 | 8.0 | 5,257.31 | 37.400 |
| 2005 | 43,561.0 | 1,447.5 | 3.3 | 6,135.90 | 375.364 |
| 2007 | 48,709.2 | 1,905.0 | 4.0 | 6,723.20 | 242.300 |

Source: (Shalloof *et al.*, 2009)

Table 2.6 shows that between 1970 and 2007 there was a marginal increase in the contribution of the agricultural sector to the total GDP. However, there has been a sharp decline in the contribution to GDP since the year 1995, which may indicate that despite the development programmes, agricultural growth is weak and lacking support. Table 2.6 shows that between 1970 and 2007 the agricultural sector contribution to GDP was marginal and it did not contribute more than 9% in the best conditions. This is considered a negative indicator as the agriculture contribution and growth should at least tally with population increases over time (Shalof, 2009). The marginal contribution of agriculture to GDP is probably a result of the absence of a strategic focus on developing the sector. In addition, the agricultural sector in Libya is mainly composed of small farms that are family managed without coordination or capability to develop at a broader level.

### 2.5.2 Libyan Agricultural Institutions

Agricultural institutions play a significant role in agricultural development; through these institutions the government implements its aims and objectives by different agricultural plans and programmes. The government recognises the role of these institutions and develops them across the country. The following is a list of the important agricultural organizations in Libya.

1. People's Committee of Agriculture and Animal Production (Ministry of Agriculture )
2. Man-Made River Organization
3. General Environment Authority
4. Agricultural Bank
5. Rural Development Bank
6. General Water Authority
7. Algabal Al-kdar Agricultural Region
8. Al-Kofra and Al-Sarir Agricultural Region
9. Fazzan Settlement Region
10. Fazzan Agricultural Region
11. National Committee to Combat Desertification
12. National Committee to Combat Desert Locusts
13. Agricultural Societies
14. Faculties of Agriculture
15. Colleges of Agriculture
16. Agricultural Police
17. General Authority for Animal Health Care
18. Aljafara Agricultural Region

### 2.5.3 Agricultural Inputs

#### 2.5.3.1 Chemical Fertilizer and its Consumption

Fertilizer plays an important role in increasing productivity. Farmers' usage of fertilizer depends on factors such as their ability to buy fertilizers; condition and type of soil; type of crop; knowledge about the use of fertilizer; and the availability of fertilizer in the market.

**Table 2.7 Fertilizer Consumption in Metric Tonnes, 1995 - 2002**

| Year | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | Year |
|---|---|---|---|---|---|---|---|---|---|
| Fertilizer | CONSUMPTION | | | | | | | | |
| Nitrogenous Fertilizer | 30,000 | 16,600 | 17,500 | 20,000 | 43,600 | 31,700 | 20,700 | 17,700 | 30,000 |
| Urea | 1,600 | NA | NA | 8,000 | 27,500 | 23,000 | NA | NA | 1,600 |
| Phosphate Fertilizer | 55,000 | 40,400 | 40, 900 | 27,000 | 34,700 | 18,000 | 47,000 | 39,200 | 55,000 |
| Potash Fertilizer | 4,000 | 5,400 | 3,300 | 3,500 | 8,200 | 5,300 | 5,500 | 5,000 | 4,000 |
| Total Fertilizer | 89,000 | 62,400 | 61,700 | 50,500 | 86,500 | 55,000 | 73,200 | 61,900 | 89,000 |
| Urea Production | 409,500 | 398,800 | 383,400 | 408,200 | 368,860 | 407,100 | 365,200 | 389,600 | 409,500 |

Source: (Laytimi, 2006)

Table 2.7 shows that increase average of the total fertilizer consumption over the eight years (1995-200) from 67,500 Mt (metric tonnes) per year, with an average of 32 kg/ha of arable land to 89,000 Mt and then decreased in 1998 to its lowest point of 50 500 Mt. In 1999, it rose sharply back to 86,500 Mt, close to the level of 1995. In 2000, it again fell drastically, but picked up in 2001. In 2002, total consumption was 61,900 Mt, still less than the 1995 level (Laytimi, 2006). However, the total fertilizer consumption over the years could probably be due to the result of climatic conditions, land availability and the country's reactions to UN sanctions during this period. As well as producing about 140,000 Mt of chemical fertilizer, Libya also imports fertilizer (Laytimi, 2006).

Table 2.7 above shows that in the eight year period between 1995-2002, average total fertilizer consumption was 67,500 Mt (metric tonnes) per year, with an average of 32 kg/ha of arable land. Total consumption steadily decreased from 89,000 Mt to its lowest point of 50,500 Mt in 1998.

### 2.5.3.2 Pesticides and Chemical Materials

Conventional agriculture intensively uses chemical materials and pesticides. This is due to the desire of farmers to increase their yield. The availability of the chemical materials and pesticides, as well as good agricultural infrastructure, enhances a farmer's likelihood of using these materials. Analysis of the quantity of pesticides and chemical materials used over the years shows the awareness of the government and farmers in using chemical materials and the effect on the environment. It also indicates the extent of agricultural infrastructure such as roads, and of credit and financial institutions to facilitate the use of agricultural inputs.

**Table 2.8 Quantity of Chemical Materials and Pesticides (in Tonnes) Permitted by the Libyan Environment General Authority, 1987 - 2001**

| YEAR | AGRICULTURAL PESTICIDES | CHEMICAL MATERIALS |
|---|---|---|
| **1987** | 729 | 33,648 |
| **1988** | 1,729 | 26,564 |
| **1989** | 790 | 986,253 |
| **1990** | 1,033 | - |
| **1991** | 2,057 | - |
| **1995** | 1,398.3 | 38,458.1 |
| **1996** | 256.6 | 80,284.3 |
| **1997** | 2,784.5 | 79,438.7 |
| **1998** | - | 139,648.4 |
| **2000** | - | - |
| **2001** | - | 36732 |

Source: The General Environment Authority (2002)

Table 2.8 shows that the use of pesticides and chemical materials increased rapidly between 1987 and 2001. This could be due to factors such as an increase in farmers' awareness about the use and benefits of such chemicals and how they could affect the development of agriculture; the availability and accessibility of agricultural infrastructure, especially roads, communication and information services; credit and financial institutions; and agricultural research and extension services.

### 2.5.3.3 Seeds and Seedlings

During 1995-2002, 25% of the annual average of 199,000 tonnes of cereal produced was used as seeds. The development and use of improved seeds depends on many factors such as the availability and accessibility of infrastructure. This will be discussed in detail in Chapter 3.

### 2.5.3.4 Agricultural Mechanisation

Libya recognises the role of agricultural machinery in improving agricultural practices and methods. Farmers are aware of the crucial role of agricultural mechanisation in increasing productivity. Farmers' tendency to use agricultural machinery depends on agricultural infrastructure such as roads; these play a significant role in facilitating agricultural mechanisation. According to AOAD (2005), Libya imported an annual average of about 25 million USD of machinery, tractors, harvesters-threshers, milking machines and other agricultural machinery such as seeders, hay rakes and pumps from 1995 to 2003. Table 2.9 below shows the growth of two types of agricultural mechanisation, tractors and harvesters, between 2001 and 2008.

**Table 2.9 Growth in Agricultural Machinery, 2001 - 2008**

| Agricultural Mechanism Types | 2001-2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|
| Agricultural Tractors | 39,747 | 39,750 | 39,750 | 39,750 |
| Agricultural Harvesters | 3,429 | 3,410 | 3,410 | 3,410 |

Source: AOAD (2009)

Usage of machinery relates to farm size. Small farms use traditional manual methods. The highest use of machinery was on farm sizes of 5-10 ha. The use of mechanisation relates to the location of farms and is linked to agricultural infrastructure availability, as described in the following section. To have a wider view of the mechanisation of agriculture in Libya, a comparative analysis with neighbouring countries such as Tunisia, Morocco and Algeria is shown in Table 2.10 below.

**Table 2.10 Comparison of Agricultural Machinery between Libya, Tunisia, Morocco and Algeria**

| Year | Country | Total Area | Cultivated Area (000ha) | Agricultural Mechanism Types | | % of Mechanism in Cultivated Area (Ha) | |
|---|---|---|---|---|---|---|---|
| | | | | Agricultural Tractors | Agricultural Harvesters | Tractor/ H | Harvesters/ H |
| 2001-2005 | Libya | 175954.00(2004) | 2644.00 | 39,747 | 3,429 | 66 | 771 |
| | Tunisia | 16230.00 | 5164.16 | 39,593 | 2,968 | 130 | 1739 |
| | Morocco | 71085.00 | 8935.30 | 46,720 | 3,863 | 191 | 2312 |
| | Algeria | 238174.10 | 8196.82 | 79,291 | 9,421 | 103 | 869 |
| 2006 | Libya | 175954.00 | 2644.00 | 39,750 | 3,410 | 66 | 775 |
| | Tunisia | 16230.00 | 5227.99 | 39,069 | 2,754 | 133 | 1897 |
| | Morocco | 71085.00 | 8946.60 | 43,226 | 3,763 | 206 | 2377 |
| | Algeria | 238174.10 | 8403.57 | 102,363 | 12,418 | 82 | 676 |
| 2007 | Libya | 175954.00(2004) | 2644.00 | 39750 | 3,410 | 66 | 775 |
| | Tunisia | 16230.00 | 5163.00 | 39069 | 2,754 | 132 | 1874 |
| | Morocco | 71085.00 | 8959.80 | 43300 | 3,900 | 206 | 2297 |
| | Algeria | 238174.10 | 8414.67 | 103,558 | 12,554 | 81 | 670 |
| 2008 | Libya | 175954.00(2004) | 2644.00 | 39,750 | 3,410 | 66 | 775 |
| | Tunisia | 16230.00 | 5186.42 | 39,069 | 2,754 | 132 | 1883 |
| | Morocco | 71085.00 | 8980.90 | 43,300 | 3,900 | 207 | 2302 |
| | Algeria | 238174.10 | 8424.76 | 104,529 | 12,650 | 80 | 665 |

Source: AOAD (2009)

Table 2.10 shows that Libya has a high position in ownership of agricultural mechanisms such as agricultural tractors and agricultural harvesters in the total of cultivated areas by hectare, in comparison with neighbouring countries such as Tunisia, Morocco and Algeria. Therefore, Table 2.10 shows that in 2001-2005, Libya's total cultivated area was 2,644.000 hectares and 39,747 agricultural tractors and 3,429 agricultural harvesters were owned. This indicates that there is one agricultural tractor per 66 hectares and one harvester per 771 hectares, while in Tunisia the figures show one agricultural tractor to 130 hectares and one harvester to 1739 hectares. The figures also show that Morocco's agricultural mechanism position was lower than that of Libya or Tunisia when comparing the cultivated areas owned. Thus, Morocco had one agricultural tractor per 191 ha and one agricultural harvester per 2312 ha. The table also shows a slight increase in the total numbers of agricultural machinery in Algeria in the years 2006, 2007 and 2008. However, in spite of this increase in the total number of agricultural tractors and agricultural harvesters, Libya is still in the highest position for the total numbers of machinery out of the total cultivated area. This result indicates that Libyan policy regards agricultural machinery as very important.

## 2.6 Agricultural Infrastructure in Libya

Agricultural infrastructure is that which serves agriculture's needs at all levels. This is starting from the small individual farm needs through regional and up to the national level. This section therefore gives an insight into the agricultural infrastructure in Libya and discusses how it contributes to the development of agriculture.

Agricultural infrastructure affects the choice of type of production and determines the agricultural inputs. Agricultural infrastructure in this study refers to six physical infrastructures: roads; communication and information services; processing infrastructure; irrigation and public access to water that contains sources of water and irrigation systems; agricultural research and extension services; and credit and financial institutions and markets.

### 2.6.1 Road Transport Infrastructure

The road and transportation network is considered a key element for the success of the agricultural sector in marketing products and communicating with other markets. It determines the production level, types of crops, prices, alternative markets and choices. Libya's transportation network is a legacy of the Al-Fatah Revolution. The Revolution era played an important role in exchanging agricultural produce and other agricultural materials inside and outside the country. This is especially true with neighbouring countries such as Tunisia, Egypt and Algeria.

Road transportation plays a crucial role in the timely delivery of production and consumption commodities. Rural roads, which are called "agricultural roads" in Libya, deliver to remote areas the goods and services required for agricultural production. The road system is vital to collecting produce from the farms, and bringing materials and other supplies in.

Libya's road network has been expanded considerably since 1978. At that time, Libya had only about 8,800 km of roads, of which perhaps one half were surfaced. By 1985, Libya had between 23,000 and 25,600 kilometres of surfaced roads. This includes surfaced roads between the north and the southern oases of Al Kufrah, Marzuq, and Sabha. By 1999, Libya had an estimated total road network of 83,200 kilometres, of which 47,590 kilometres were not tarred (Shrf, 1996). These roads have helped in linking the isolated remote areas to urban centres. The agricultural projects under way in the desert oases have particularly benefited from the more efficient crop marketing made possible by these roads.

Today the key road in Libya is the 1,822 kilometres national coastal highway. It runs from the borders with Tunisia to the Egyptian border, and passes through Tripoli and Benghazi. About two-thirds of Libya's roads now have a bitumen surface (Library of Congress: Federal Research Division, 2005).

### 2.6.2 Access to Water

Libya is an arid country with limited water sources. According to FAO estimation, the agriculture sector accounts for 80% of water use in Libya (FAO, 2005). The total volume of fresh water available for use in the country is 3,990 million $m^3$ per year (Water Public Corporation, 2008). Of this amount, 120 million $m^3$ comes from surface water, and 3,430 million $m^3$ comes from the annual recharge of underground water aquifers. About 140 million $m^3$ comes from desalination water of which about 25% is used for agriculture (Laytimi, 2005). Treated or recycled water accounts for about 300 million $m^3$ per year. The aquifers that are recharged are the ones that are in the north-western and the north-eastern zones of the coastal plain. The water resources available in Libya are classified as underground water, surface water, desalinated water, and treated wastewater (see table 2.11).

**Table 2.11 Total Water Resources in the Jamahiriya, 1990 - 2025 (Million Cubic Metres)**

| Sources | 1990 | 2000 | 2010 | 2020 | 2025 |
|---|---|---|---|---|---|
| Underground Water | 3,430 | 3,430 | 3,430 | 3,430 | 3,430 |
| Surface Water | 60 | 120 | 120 | 120 | 120 |
| Desalination Water | 100 | 130 | 140 | 150 | 160 |
| Treated Water | 110 | 110 | 300 | 450 | 520 |
| Total | 3,700 | 3,760 | 3,990 | 4,150 | 4,230 |
| Needs | 4,757 | 5,579 | 6,576 | 7,784 | 8,965 |
| Deficit | 1,057 | 1,679 | 2,586 | 3,634 | 4,735 |

Source: Water Security in Libya, Water Public Corporation (2008)

Libya has about sixteen dams with a total storage capacity of about 385 million $m^3$ (Laytimi, 2005). The potential for irrigable land in Libya is around 2 million ha, while the area currently irrigated is 200 thousand ha, only 10% of the potential land.

Most of the Libyan population live in the north by the coastal zone where the best arable land is located. However, there is a lack of water in the north due to low levels of rainfall. The Libyan State established the Great Man-Made River Project, which started in the 1980s to transport about 2,300 million $m^3$ per day of fossil water by pipeline. The length of the pipeline is about 3,000 km from the south to the north. The Great Man-Made River alleviates the severe water shortage in Libya, satisfies the increasing demand of water use for domestic and industrial purpose and irrigates about 750,000 ha (Laytimi, 2005).

#### 2.6.2 .1 Water Resources

*2.6.2.1.1 Underground Water*

Underground water is the most important of the water resources in the country: it represents 95% of these (Algheriani, 2003), and the agriculture sector consumes over 80% of the total underground water.( Algheriani, 2003) The rest is used as drinking water and for industrial purposes. Underground water resources are concentrated in five main underground reservoirs. These are:

1. The Sahil Alajafara
2. The Marzuq
3. Al-Kufra and al-Sarir
4. The Algabal Al-kdar
5. The Nufusa

The main source for recharging the aquifers is ground water in the northern regions, namely the northern-western zone, which includes Jabal Nafusah and the Jifarah Plain, and the north-eastern zone, which includes Algabal Al-kdar. Renewable groundwater resources are estimated at 800 to 1,000 million $m^3$/year, but almost 50% of it flows out either to the sea or to evaporative areas (Sabkhas). Not all the renewable ground water can be utilised without affecting the environment because of the deterioration of the water quality by saline water encroachment; this limits the safe yield to an estimated 500 million $m^3$/year. South of the 29th parallel, an important development of Palaeozoic and Mesozic continental sandstone caused large amounts of water to be stored during the long period of the late Quaternary, before the climate turned extremely arid. Most water used in Libya today comes from these huge fossil reserves (Pallas, 1980).

The Great Man-Made River project delivers about 2K $m^3$/year of fossil water from the desert area in the south to the coastal area in the north. This water is mainly for irrigation but some is used to supply major cities with its water needs including drinking and domestic needs.

*2.6.2.1.2 Surface Water*

Surface water includes rainfall held by means of dams and tanks. Sixteen dams, with a total storage capacity of 387 million cubic metres with an average annual volume of water have been constructed since 1991(Algheriani, 2003) The quantity of water retained by dams was estimated to be 120 million $m^3$ in 2001 (Algheriani, 2003), and additional dams are planned to achieve a total storage capacity of 686 million $m^3$ (Algheriani, 2003).

*2.6.2.1.3 Desalinated Water And Treated Wastewater*

Desalinated water is produced through processing seawater in desalination stations located on the coastal strip of the country. The total annual production of such stations is estimated at 130 million cubic metres. This desalination process is costly and makes it an unviable source for agricultural supply though several attempts have been made during the last 20 years to introduce and expand seawater desalination plants and wastewater treatment facilities (Algheriani, 2003). A number of desalination plants of different sizes have been built near large municipal centres and industrial complexes. The total capacity of the plants is approximately 140 million $m^3$/year, but sections of them are either not in use or only partly operational. It is estimated that only 70 million $m^3$ of water are desalinated each year. Currently all desalinated water is used for domestic and industrial purposes (Salam, 2005).

Recycled water is produced through recycling of sewage water, and it is used for the irrigation of some agriculture projects that are close to communities and cities. The total production of treatment plants is estimated at 120 million $m^3$ / year. The present capacity of wastewater treatment is estimated at about 100 million $m^3$ /year and all treated wastewater for agricultural purposes (Salam, 2005).

### 2.6.3 Communication and Information Services

Libyan telecommunication and internet services are less developed and more expensive compared with other North African countries. According to 2003 estimates, 750,000 fixed lines and 100,000 mobile phones were in use at that time in Libya. July 2004 estimates reported that fixed lines decreased to about 700,000, while mobile subscribers increased to about 150,000. These figures represent less than 13% and 3% of the population, respectively. The Al Madar Telephone Company, which is a monopoly, started operating its mobile phone service in 1996 and is now planning to increase its mobile subscribers to 250,000.

In 1997, 730,000 televisions and 1.35 million radios were in use in Libya. In 1999, 12 television stations were broadcasting, and by 2002, sixteen on AM, three on FM, and three shortwave radio stations were also operating. These reach audiences locally, regionally, nationally and internationally. In 2003, Libya had sixty-seven internet providers and more than 160,000 internet users (Library of Congress: Federal Research Division, 2005).

Porter and Yergin (2006) reported that telecommunication infrastructure in Libya needed more development and noted that neither broadband internet access nor roaming access for major international mobile networks are commonly available.

### 2.6.4 Credit and Financial institutions

In 1970, the Libyan government nationalized all banks in Libya. In March 1993, a new law allowed the establishment of private-sector banks, but to date the only foreign banks in Tripoli are the Arab Banking Corporation, the Bank of Valetta from Malta, and the Suez Bank of Egypt (Library of Congress: Federal Research Division, 2005).

Porter and Yergin (2006) stated that financial infrastructure in Libya is insufficiently developed for the needs of foreign investors. For instance, there are fewer than twenty ATM machines in Libya, and credit cards can only be used in international airline offices and a few major hotels. The country also recognized the importance of finance to the agriculture sector and established the Agricultural Bank in 1957 to facilitate agricultural development in the country.

Agricultural Banks in Libya are the main financial bodies supporting the agricultural sector (Agricultural Bank Law). The financial services and support extended to agricultural projects is considerable: the most supportive to the national economy for more than 45 years (Agricultural Bank Report, 2005). Table 2.12 below shows the distribution of bank branches across the agricultural regions in which this study was conducted.

The Agricultural Bank is a state enterprise. It was founded in 1955 and commenced operations in 1957 with a capital of one million Libyan Dinars. The paid up capital of the bank comes through the government budget. This capital has increased over time to cope with the increasing need to support agricultural projects and to match with government policies to develop this sector. This initial capital increased to 55 million Libyan Dinars in 2001, and then grew to 56 million Libyan Dinars in 2002. In 2003, the government decided to increase the paid in capital to 451.7 million Libyan Dinars

**Table 2.12 Total Number of Agricultural Banks in the Research Area**

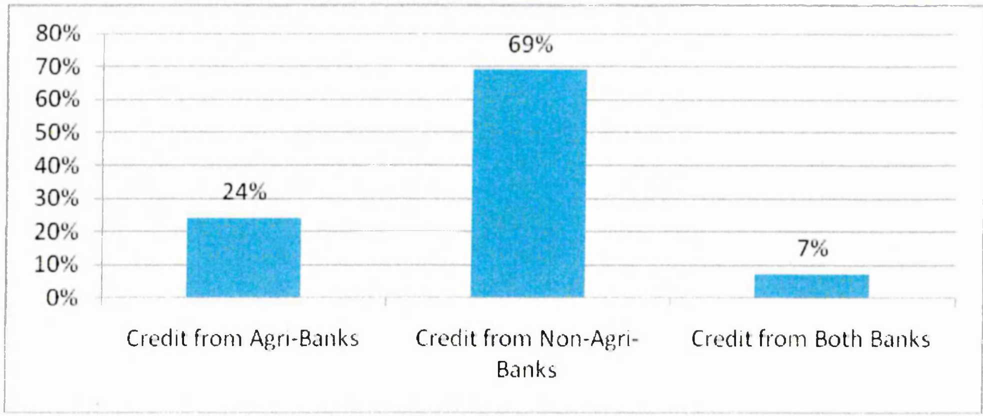
| Agricultural Region | Number of Agricultural Banks in the Region |
|---|---|
| Algabal Al-kdar Region | 4 |
| Aljafara Region | 20 |
| Fazzan Region | 8 |

Source: Agricultural Bank Report (2005)

The Agricultural Bank plays an important role in coordination with the Ministry of Agriculture and the Water Association, and in implementing the agricultural strategies and policies of the government. The Agricultural Bank also provides banking services similar to that in the conventional banks but is guided by government policies that focus on development of the agricultural sector.

In 2007, the total amount of money provided as credit to agricultural development accounts was about 587million LYD.

**Figure 2.8 Distribution of Credit Among Formal Lenders**




Source: Ahmed (2010).

In a study by Ahmed (2010), about the extent of farm credit in the Libyan agricultural sector the analysis is based on rural-household surveys in 3 rural areas in Libya. Therefore, Figure 2.8 shows, in the result of the survey, that non-agricultural banks provided 69% of credit to farmers, whilst agricultural banks provided 24%. Both banks gave a shared 7%. This provided the total amount of 587million Libyan Dinars in 2007. The figure of 7% means that only 7% of the households who participated in the study were borrowers from both agricultural bank and non agricultural banks. However, this result also shows that non-agricultural banks were more involved in the development of the agricultural sector than the agricultural banks. This means that the contribution by the agricultural banks to agricultural development is still not sufficient. However, this could be due to the weakness of agricultural policies in the country or due to government policy in introducing some organization which plays an important role in achieving government policies in transformation for people by providing subsidies for them to build private projects such as agricultural projects and industrial projects as a new direction to decrease the rate of unemployment in the country.

Ahmed (2010) indicates that access to credit in Libyan rural areas is determined by socio-economic characteristics of the households, such as the head of household, gender, marital status, level of education, monthly income, and other factors such as farm productivity, water availability, type of soil, livestock-holding and household's assets. Education level and monthly income of the head of the household are important factors in determining access to credit in Libya. Therefore, the heads of households who have a better education, a permanent job, and a monthly income from off-farm activities have better chances of access to credit than those who are poorly educated.

Ahmed (2010) finds that land productivity, soil type and water availability in the farm also have a significant impact on credit among households in Libya. This result is not surprising if we take into consideration the dry climate in Libya, where the average rainfall is low in the northern part of the country and where there is no rainfall in the middle and southern parts. Owning land, even large areas, without permanent water sources and good quality of soil will not be profitable for investment in agriculture activity. Farmers who have permanent water sources on their farm, for example groundwater, have an 18% higher probability than other farmers who depend on rainwater.

Ahmed (2010) indicates that the use of agricultural machinery and family size have no impact on access to credit but have a significant impact on applying for credit. He also notes that livestock holding has a significant impact on applying for credit. Rural families holding livestock have a 37% higher probability of applying for credits compared with families who do not hold livestock. Ahmed (2010) states that around half of the rural population in Libya has no access to credit.

### 2.6.5 Processing Infrastructure

Worldwide food processing is a large sector that comprises activities such as agriculture, horticulture, plantation, animal husbandry and fishery. It also includes other industries that use agricultural inputs for the manufacture of edible products. Libya has many industrial food projects such as cereal, vegetables and dry fruit projects. However, most of the raw materials used in the processing sector are imported (Almahdowee, 1998). This is an issue for farmers since the processing chain adds cost to the product.

### 2.6.6 Agricultural Research and Extension Services

Agriculture research in Libya aims to achieve and reinforce scientific studies for the development of agriculture (Abidar and Laytimi, 2005). In 1998, the National Agriculture System (NARS) of Libya included three scientific institutions (AOAD, 1998; El Azzabi, 1999). These were mainly involved in agricultural research and classified as the Agricultural Research Centres (ARCs), the Animal Studies and Research Centre, and the Marine Biology Research Centre. Furthermore, there are seven university faculties of agricultural and veterinary medicine involved in agricultural research.

ARCs are affiliated to the Peoples' Committee of Agriculture and Animal Production. The headquarters of the ARCs is located in Al-Beida city in the Aljabal Al-Akhdar region and its branches are distributed across the agricultural regions. The objectives of the ARCs are as follows:

- To set up a general plan for agricultural research;
- To gather, classify and evaluate research, technical and socio-economic studies;
- To carry out studies related to development of natural resources and the resolution of problems of oases and arid regions;
- To cooperate with the extension services for the diagnosis of agricultural problems, their resolution and the implementation of the results of research.
- To organise scientific activities (forums, seminars etc.) (Abidar, 2004).

The Peoples' Committee of Agriculture and Animal Production is responsible for allocating and funding the ARCs, which work under the supervision of the National Authority for Scientific Research (NASR). The latter is supposed to formulate and supervise the national research policy. However, the role of agricultural research in Libya is limited and weak due to the limitation of financial resources and the lack of expertise in the research field and the lack of technological support. Moreover, one of the major weaknesses of agriculture research in Libya is that its activities do not match the current agriculture problems, even though agricultural research has been engaged in many areas of agricultural development. Azzabi (2008) states that in the last two decades, government agricultural research in Libya took over responsibility for solving some problems and obstacles for farming. This was through consulting and research and indicated that the most important agricultural research programmes should be designed to help Libyan agriculture in areas such as quality of agricultural production which needs to be improved. This means that instead of cultivating more land with a low yield and deteriorated quality, it is desirable to improve local varieties (tolerant to water stress, salinity and high temperature, and with high yield), and improve local sheep and goat breeds for better production of meat and dairy products. There is also a need for technology transfer to small landholders, improvement in the management of range lands, and control of desertification. But this current research demonstrates many weaknesses of farmers' understanding of key agricultural methods such as biological control, and a high proportion of farmers without links to agricultural research and extension services. Furthermore, the degradation of soil has been increased due to farmers' limitation knowledge and to the lack of research in this area. It was also noted that farmers had not used manure fertilizer extensively but were dependent on chemical fertilizer. This could be due to many reasons such as farmers' knowledge, fertilizer availability, fertilizer prices, and lack of the research into manure fertilizer. The research also found that conventional irrigation is still used intensively in the country despite the serious problem of shortages of water. Furthermore, the researcher suggested that it does not communicate regularly with farmers to address their agriculture problems.

## 2.7 Agricultural Policies and Development Plans

Agricultural policies in Libya are based on the government's vision of agricultural development. This vision was expressed in two main sets of agricultural policies. The first were implemented during the period 1952-1968 and the second during the period 1973-2007. The first stage of the policy was during the Libyan Kingdom and the second was during the Republic of Libya and Jamahiriya era.

### 2.7.1 The First Agricultural Development Plan, 1952-1968

The first agricultural plan aimed to develop the agricultural sector by improving land access, source of groundwater by drilling wells, and sand dune stabilization (Al-Arbah, 1996). The aim of the policy was to increase the level of food production in Libya and the alleviation of poverty. It also intended to raise the quality of life and provide education and training to farmers, and to develop rural areas.

However, implementing this plan faced a number of difficulties such as lack of funding, poverty, unemployment and high level of illiteracy, and the spread of diseases (Al-Arbah, 1996). There were also challenges such as a questionable government commitment to implement the policy, a shortage of agricultural technical labour, technical information and economic research, and a lack of funding (Al-Arbah, 1996).

### 2.7.2 The Second Agricultural Development Plan, 1973-2007

The second agricultural development plan was aimed at developing and diversifying the agricultural economy of Libya. It was directed towards achieving socio-economic benefits through the establishment of agricultural projects at community levels to optimize the use of natural resources (Al-Arbah, 1996).

The government implemented a policy to settle communities of nomadic people by assisting them to develop farms at no cost (GPCP, 2007). This policy was to diversify the economy and achieve self-sufficiency in some agricultural produce such as milk, eggs, vegetable, fruits (Al-Arbah, 1996). Several programmes such as the Programme of Development of Grazing Land, the Programme of Development of Forests, the Programme of Water Resources and Dam Development, the Programme of Extension and Agricultural Cooperation were set up. Farmers were also supported by subsidies and loans to increase their ability to purchase the necessary inputs of materials, services, and technology. The main objectives of the second agricultural development plan were as follows:

- To increase the level of income of the farmers to reach 2700-3000 LYD yearly;
- To achieve self-sufficiency in vegetables, grain, fruits, meat;

- The conservation of natural resources such as soil and underground water;
- To increase revenue for the people who work in agricultural activities so as to be equal in income to other business sectors;
- To address issues of population distribution by developing agricultural settlement centres in new agricultural areas (Abidar, 2004)

The policy of the second agricultural development plan focused on the conservation of natural resources, especially soil and water. Investment in water resources was considered essential in order to draw attention to water as an important resource for agriculture in the country. The policy strengthened agricultural cooperation among extension services and agricultural societies and offered effective support to agricultural mechanization (GPCP, 2007).

The implementation of the policies in this period faced problems such as the United Nations' sanctions on Libya which led to a sharp decline in agricultural production, thereby decreasing the performance of agriculture and the economy. Since 1985, agricultural policies have been implemented through annual plans instead of the triennium or the fifth plan. The change to annual plans was attributed to the United Nations' sanctions on Libya.

The researcher noted that government policy in agriculture focused on food security, self-sufficiency and utilization for neutral resources, and this has been achieved by supporting farmers through loans and subsidies. Support to farmers has been in two main areas:

- Inputs support policy
- Outputs support policy (pricing policy).

The input support policy aimed at increasing the farmers' ability to purchase agricultural inputs. This was achieved by supporting farmers to purchase agricultural inputs such as fertilizers, seeds, machinery and pesticides. Such support led to an increase in cultivated areas and increased production. Subsidies of fertilizers, seeds and equipment reached to 80% of their market price, pesticides to 60% of its market price, and agricultural machinery to 50%

of its market price for the cooperative societies and 25% of its market price for individuals. Power-lines and water projects were extended in the main agricultural regions. The total amount of money spent on subsidies from 1970-1980 was about 165 million LYD (AOAD, 2005).

Outputs support policies subsidised prices of specific types of crops such as grain, wheat and barley. These crops were supported because they are the most widely consumed food in Libya. Outputs support policies guaranteed prices to farmers to enhance the implementation of government policies and for the development of the agriculture sector's sustainability. This policy decreased the deficit gap in grain production (AOAD, 2005).

Agricultural policies in Libya have changed over the study period. The plans were designed to achieve specific targets and aims. The First Agricultural Development Plan (1952-1968) was to improve the sources of water for agriculture, to increase production of food to alleviate poverty, and to protect agricultural areas from sand dune stabilization. However, due to lack of funding the plan faced many obstacles and barriers. Illiteracy was high among the people, and there were problems with the spread of diseases, unemployment, shortage of agricultural technical labour, and lack of technical information or economic studies. The Second Agricultural Development Plan (1973-2007) saw a remarkable increase in agricultural activities. Government agricultural policies and development plans focused on achieving self-sufficiency in vegetables, grain, fruits and meat (Shalloof *et al.*, 2009).

## 2.8 Motivation to Transfer to Organic Farming in Libya

Statistics show that 85% of the total number of sheep, goats and camels, equivalent to 5,088,000 heads, graze on natural pastures. The increase in the number of livestock from 1984 to 2007 is shown in Table 2.13 below. The majority of livestock production in the country was considered as organic, though they were not certified. Agricultural infrastructure such as roads and communication services, credit and financial institutions, research and extension services facilitated this achievement. However, agricultural infrastructure is still not widely available and accessible in the grazing areas, which are far from the urban zones. Therefore, the researcher's suggestion is that the increase in livestock production in Libya could provide a major opportunity to transform to organic farming practices. Livestock are considered the main source for manure fertilizer. Therefore, the use of the available of minor fertilizer depends on the conditions of the current situation of the infrastructure in place. This means on the addresses hypothesis of this research. The following table indicates the potential of the availability of organic manure in Libya.

**Table 2.13 Increase in the Number of Livestock from 1984 to 2007**

| Resource | Number Of Livestock | | | | | |
|---|---|---|---|---|---|---|
| | 1984 | 1986 | 1987 | 1988 | 1989 | 2007 |
| Cattle | 90,095 | 210,000 | 212,000 | 215,000 | 240,000 | 102,506 |
| Goats and Sheep | 4,831,014 | 1,505,000 | 6,660,000 | 6,715,000 | 6,770,000 | 5,068,071 |
| Camels | 73,212 | 180,000 | 180,000 | 185,000 | 190,000 | 109,397 |
| Horses and Donkeys | NA | NA | NA | NA | NA | 11,399 |
| Poultry | 6,839,071 | 30,000,000 | 36,000,000 | 37,000,000 | 37,000,000 | NA |

Source: Libyan Agricultural Census (2007)

Whilst government initiatives to introduce organic agriculture in Libya are still in their embryonic stage, the country has already joined a number of international organic organizations such as the Mediterranean Organic Agriculture Network (MOAN). This body aims to promote and develop organic agriculture across the Mediterranean zone (Al-Bitar, 2008).

Environmental concerns are one of the most important issues for establishing organic farming in Libya. This follows a pattern that has emerged in developed Western economies. According to Thompson (1998), in developed countries, farmers' and consumers' demands for environmental and health quality created the organic agriculture movement. However, in Libya a variety of agricultural enterprises using modern agricultural techniques to increase productivity has been developed. These practices rely on the intensive use of chemicals such as fertilizers and pesticides. Such intensive farming practices have led to contamination of underground water, soil degradation and other serious forms of environmental pollution (Aljandeal, 1978). Many technical problems have emerged and serious environmental problems in Libya have led the Libyan Peoples' Congresses to enact laws on environmental protection. These laws aim to minimize environmental pollution through scientific disposal of waste and garbage, controlling the use of pesticides and chemicals produced or imported, and protecting water resources (Libya Environmental Magazine, 2005).

Several studies conclude that concern over health is one the most important motivations for establishing organic farming systems (Al-Arbah, 1996; Roberts, 2011; Magkos *et al.,* 2006). These studies suggest that organic farming has been developed in most Western countries because of the awareness of the whole society about the hazardous effects of highly industrialised conventional agriculture on the health of human beings and nature. Al-Arbah (1996) indicated that in spite of the effectiveness of using chemical pesticides to control pests and disease, many of these chemical pesticides are harmful to human health and animals. They also cause pollution to ground water and soil, and affect non-target animals.

In addition, Najdee (2006) notes the dangers of food additives and states that food additives affect health. There is an increased awareness of health and environment issues, and higher disposable incomes enable people to make "lifestyle choices" such as paying more for food they feel will be better for them and less damaging to the environment. Millstone and Lang (2002) state that consumer demand for organic produce in the industrialised world is growing steadily. The effects of environmental problems can be seen in the increasing rates of related disease and this has increased consumers' awareness of their food sources.

Libya's economy depends mainly on oil and gas but this over-dependence has threatened or weakened some of the state's development plans in other economic sectors, particularly the agricultural sector. The government has been seeking alternative national income sources, focusing on the agriculture sector with its huge potential resources (Al-Gamatee, 2000). Organic agriculture can be used in developing countries such as Libya to earn foreign exchange and this has been demonstrated for other North African and Mediterranean countries (Rehber and Turhan, 2002). Environment, social and economic benefits serve as motivation drivers for Libya to develop organic farming. For the farmers too, organic produce can be an 'added value' commodity.

## 2.11 Summary

This chapter explored the development of agriculture in Libya. It discussed the environmental context and the role of the national government in the provision of agricultural infrastructure and its effect on the development of agriculture. It identified the various agricultural institutions in Libya and the supply of agricultural inputs. The objective of this chapter was to give an overview of agricultural activities in Libya to help in the discussion of how agricultural infrastructure and accessibility promotes the development of organic farming in Libya, which are explored in the next chapter.

# CHAPTER THREE

## AGRICULTURAL INFRASTRUCTURE AND TRANSFORMATION TO ORGANIC FARMING

### 3.0 Introduction

The objectives of this chapter are first to explore the availability of and accessibility to agricultural infrastructure and how it impacts on agriculture. Second, the chapter helps to gain an understanding of how of the current agricultural infrastructure in Libya can help any transformation to organic farming practices. The chapter discusses definitions of agricultural infrastructure, the various types of infrastructure such as transportation, telecommunication, agricultural processing facilities, research and extension services, irrigation systems, financial services and markets and their contribution to agricultural development. The second part of this chapter reviews the relevant literature on organic farming. The key themes from these reviews will be used, together with the data collected and presented in Chapter 6, to discuss how the current agricultural infrastructure in Libya might support transformation to organic farming.

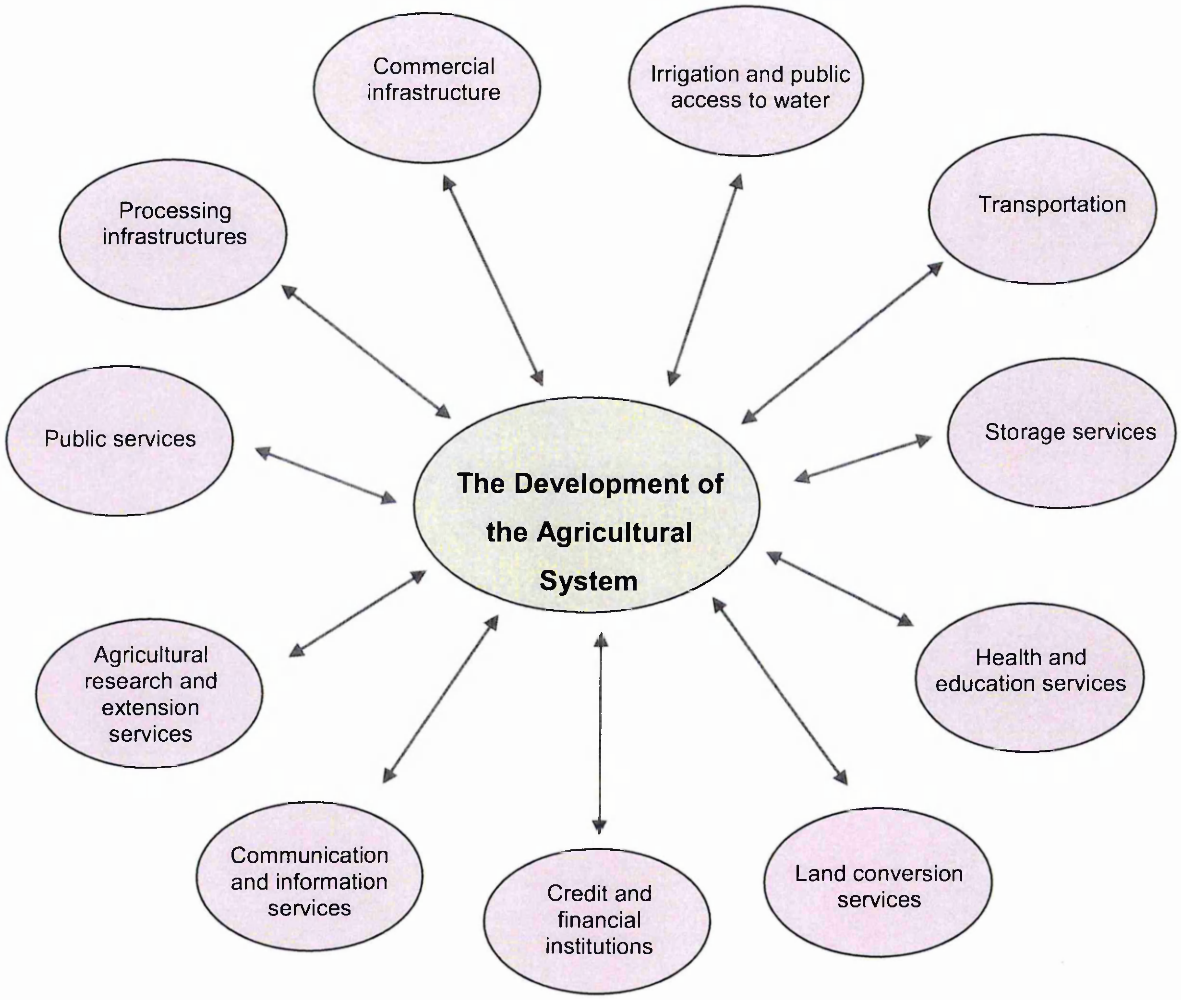
### 3.1 Agricultural Infrastructure Definitions and Concepts

Agriculture infrastructure is an important input into the development of agriculture. This implies that agricultural infrastructure such as transportation, electricity, water systems, seeds, fertilizers and irrigation sources can be organized and maintained in such a way as to achieve the maximum benefit for development in the agricultural sector. Factors such as improved soil productivity, the supply of balanced crop nutrients, efficient water management, improved crops, better plant protection, post-production management for value-addition, and marketing will result in higher yields in agriculture. These factors usually depend on improvements to the availability of and accessibility to agricultural infrastructure. Generally, infrastructure systems are still inadequate in many economies of the Developing World. In many cases, the lack of available specialized inputs, capital markets, communication and transport systems, support services, and irrigation and drainage can all limit diversification (Barghouti *et al.*, 2004). However, Fosu *et al.*(1995) reflecting this broader definition, distinguish up to eleven components of agricultural infrastructure. These are:

- Irrigation and public access to water
- Transportation;
- Storage services;
- Commercial infrastructure;
- Processing infrastructure;
- Public services;
- Agricultural research and extension services;
- Communication and information services;
- Land conversion services;
- Credit and financial institutions; and
- Health and education services.

In broad terms, agricultural systems seem to be affected by a range of different kinds of agricultural infrastructures (Venkatachalam, 2003), as illustrated in Figure 3.1.

**Figure 3.1 The Agricultural System as Affected by Different Kinds of Infrastructure**




Source: Venkatachalam (2003).

There are different definitions of infrastructure in agriculture. In broad terms, infrastructure provides the base whereby all production elements interact to generate output (Jimenez, 1994, 1995; Fisher, 1927). Infrastructure comprises different types of capital or other resources that may be capable of supporting development or yielding sources of future income. Nicolls (1963) states that agricultural infrastructure can be defined through its components, which consist mainly of the sub- infrastructures of education, research, transportation, and banking and credit institutions. Kamarck (1964) derives the definition for infrastructure from the core services that should be available in the economy in order to enable production in this economy.

Wharton (1967) points out that agricultural infrastructure is actually the physical capital, including all types of institutions or organizations that provide economic services that add value and lead in a direct or indirect way to fuel the economic functioning of every single farm. Venkatachalam (2003) argues that agricultural infrastructure is defined as the basic services, facilities, equipment and institutions needed for economic growth and efficient functioning of food and fibre markets. Ahmed and Donovan (1992) recognize that agricultural infrastructure is growing in importance. It has a key role in economic development and related areas include agricultural research, extension services, financial institutions and irrigation as part of a wider concept of infrastructure. Finally, Hirschman (1958) outlines four elements that characterize infrastructure: the fundamental services that facilitate the basic economic activities; the services are usually public goods because of economic externalities; and these services cannot be imported.

Therefore, it can be said that infrastructure refers to all basic inputs into and requirements for the proper functioning of the economy. Thus agricultural infrastructure can be summarized into two groups. The first category is social infrastructure, such as education and health, which facilitate the supply of skilled and healthy personnel to manage and operate other resources. They also enhance the economic, political and social empowerment of the populace, with the attendant positive effects on efficient use of national resources. The second category is often referred to as economic infrastructure. Mody (1997) defines this category of infrastructure as the one that provides society with the services necessary to conduct daily life and to engage in productive activities. These services include power, transportation, telecommunication, water, sanitation and safe water disposal, among other things. This research is therefore devoted to the study of agricultural infrastructure in its two categories of social infrastructure, such as agricultural research and extension services, and financial institutions, and physical infrastructure which can also be called economic infrastructure, such as transportation, communication, and irrigation and public access to water.

Bouvet (2007) sums up infrastructure development through linking it to the general economic development that leads to the development of markets.

Modern markets are associated with developed services and networks of roads, communication and transportation, and such development leads to efficient infrastructure. Satish (2007) indicated that "agricultural infrastructure" services include items that facilitate the development of not only agricultural activities, but also rural activities and sometimes even urban activities.

All definitions of agricultural infrastructure focus on the fact that infrastructure is positively correlated with the level of services, economic development and long-term growth. For this study the researcher defined agricultural infrastructure as the fundamental base of capital stock and facilities needed for the functioning of the economy and to facilitate and implement the different agricultural processes and practices such as tillage, fertilization, biological and control and harvesting and marketing in an economical way in order to increase the output of agriculture and make it more diverse, productive and profitable. Therefore, it could be suggested that the important elements of agricultural infrastructure are transportation, communication and information services, processing infrastructure, electricity, financial institutions, irrigations resources and systems, agricultural research, and extension services. All of these enable agricultural output to be increased and agriculture made economically more diverse, productive and profitable.

## 3.2 Agricultural Infrastructure and Agricultural Development

Agricultural development is heavily dependent on agriculture infrastructure, as the quality and development of the infrastructure will always drive agricultural development. In broader terms, Venkatachalam (2003) defines the relationship as follows: "There are different kinds of infrastructure such as economic infrastructure, social infrastructure, financial infrastructure, technological infrastructure and agricultural infrastructure. All kinds of infrastructures are complementary to each other and are an essential and integral part of economic development."

Furthermore, Gibson and Rozelle (2003), Fan *et al.* (2003), and Wanmali and Islam (1995), have shown a positive relationship between public investment in infrastructure and agricultural growth. Remoteness of farms, due to under-provision of public services and infrastructure, translates into high transaction costs for producing and marketing goods in rural areas. The lack of infrastructure such as roads and railway automatically leads to high costs of travel and goods transportation. In addition, the lack of telecommunication raises the costs of accessing information, including information for linking producers and various types of rural and urban traders. Ashok *et al.* (2006:21) state that "irrigation, roads, markets and literacy are the important infrastructural variables which [have] had a significant positive influence on total factor productivity". According to Hulten (1996), the way or type of usage of infrastructure resources leads to real differences between countries in terms of development and this represents the difference in one-quarter of the growth between Africa and East Asia, and more than 40 percent of the growth differential between low- and high-growth countries

Thus, poor infrastructure and services raise agricultural production costs. As Temu *et al.* (2003) argue, under-served communities also suffer higher levels of risk and uncertainty in their production and marketing endeavours, and, they suggest, tend to be more risk averse, because of lack of growth (Temu *et al.*, 2003).

The following sections consider the various types of agricultural infrastructure and their effect on agricultural development.

### 3.2.1 Transportation

From as early as the 1950s, expansion and improvement of transportation and other infrastructure (electricity, waterways and telephones) were key factors in developmental strategies in Third World countries. Thus, Thanh *et al.* (2008) highlight that transportation is closely correlated with the effectiveness of agricultural marketing, which leads to ease of market reach and less damage to the transported crops. Rostow (1960) argues that increase in agriculture production and the productivity of the agricultural sector is conditioned by the expansion and improvement of transportation. Additionally, it has been suggested that transportation plays a determinant role in low technology adoption in agriculture (in developing countries) since it affects cropping, production and packing methods (Omamo, 1998; Zeller *et al.*, 1998; Von Oppen *et al.*, 1997; Antle, 1993). Moreover, rural roads network inefficiency is a major limitation for poor farmers. It constrains productivity and profitability as it increases the difficulty and cost of hauling their inputs to the farm and their outputs to the market (Chris *et al.*, 2006). Chirwa (2004) confirms this through highlighting that the use of bad roads in transportation increases the cost of transportation especially for small farmers who would have difficulty with such roads in reaching the right markets for their produce. Similarly, Temu *et al* (2003) conclude that lack of infrastructure that would facilitate transportation leads to high costs of delivering goods, crops and agricultural machinery. Furthermore, research in Uganda found that poor roads and transport networks add significantly, by 50 - 60 %, to the high cost of fertilizer and also make transporting goods to market a challenge (Namazzi, 2008).

Studies of the effect of improving roads in Tanzania have shown that such improvement has a direct effect on the welfare of the agricultural sector through creating consistent stable conditions for improving marketing, reducing costs, and establishing foreseeable strategies for farmers (Gajewski *et al.*, 2002; Lyatuu *et al.*, 2000).

Ahmed and Hussain (1990) demonstrate that there is a positive correlation between the use of fertilizer and the improvement in the quality of roads. Furthermore, research in Asia found that in villages or rural farms that are better served or connected to roads, fertilizer costs were 14% lower, wages were 12% higher and crop output was 32% higher (IFPRI, 1990). In Africa, rural road construction has been found to be associated with increases in agricultural production, especially in non-food export crops, expanded use of agricultural credit, increases in land values, proliferation of small shops and expansion of rural markets (Anderson *et al.*, 1982).

The World Development Report (2005) argues that roads and commercial vehicles increase the choices of farmers not only in the selection of better and more appropriate inputs but in the selection of efficient product markets. Roads allow farmers to move their goods more regularly and more cheaply. Ashok *et al.* (2004) note that improvement of roads and road upgrading in some areas leads to higher land productivity, as a result of easier transportation of goods.

Kurosaki (2003) suggests that road infrastructure narrows the gap between prices of markets and farms and increases the specialization of farmers.

From these studies, therefore, it is clear that transportation is one of the main important elements of agricultural infrastructure and that it plays a vital role in developing agricultural systems.

### 3.2.2 Information and Communication Services

Information and communication technology (ICT) has many potential applications in agricultural development (Zijp, 1994). It can bring new information services to rural areas where farmers, as users, gain greater control over information channels. Access to such new technology is a crucial requirement for the sustainable development of farming systems. Thus, the United States Agency for International Development (USAID, 2002) states that knowledge, communication and information flow are very important for providing farmers with the capability to manage their resources and enable them to make the right decisions at the right time, such as what to plant, when to plant, how to cultivate and harvest, and where to store, or sell, and at what price.

Similarly, according to the Food and Agriculture Organization (FAO, 1996:15), "better communications are a key requirement to agricultural development. They reduce transportation cost, increase competition, reduce marketing margins, and in this way can directly improve incomes and private investment opportunities".

Furthermore, Richardson (2003) argues that in Vietnam, the ability of farmers to communicate with the market and service providers is vital in agricultural extension, the capability to use resources, and the creation of a decentralized system.

The importance of ICT to agriculture is not new. Many traditional methods of managing and communicating information continue to be critical to developing national agriculture systems (USAID, 2003). Barghouti *et al.* (2004) explain that exchange of information is vital for small farmers since it is necessary to define market demand and profitable investment opportunities and to improve the efficiency and competitiveness of the supply chain. They add that "Information flow is very important for farmers to draw a sense of market demand and market trend. Therefore, lack of telecommunication infrastructure raises the cost of obtaining information. Furthermore, in Nepal, the lack of adequate information on organic agriculture seems to be the major reason for the non-adoption of organic vegetable farming by conventional farmers (Kafle, 2011). Other studies (Norton, 1992; Greenstein and Spiller, 1995; Yilmas, *et al* , 2001; Yilmas and Dinc, 2002) found a positive and significant causal link between telecommunication infrastructure and aggregate agricultural output. There is also evidence that telecommunications infrastructure serves as a primary source of economic growth.

Fan and Rao (2003) emphasize that investment in telecommunication and information management is essential for market growth and is also important for food security and poverty reduction, while Pinstrup-Andersen and Shimokawa (2006) point out that investing to improve the status of information and communication in developing countries, especially in southern Asia and in Africa, would participate to a significant deal in enabling farmers to obtain accurate market.

Shaik *et al.* (2004) state that ICT can give a new impetus to the social organisations and productive activities of agriculture; which if nurtured effectively could become transformational factors. The 'knowledge' itself will become a technology for overall agricultural development. They add depth to their argument by highlighting some agricultural development services that can be provided in the developing world using ICT are:

- The facilitation of interaction among researchers, extension (knowledge) workers, and farmers;
- Question-and-answer services where experts respond to questions raised by farmers;
- ICT services to developmental officials for greater efficiency in delivering services for overall agricultural development;
- Up-to-date information, supplied to farmers as early as possible, about subjects such as packaging, market information, weather forecasting, input supplies, credit availability;

- Creation of databases with details of the resources of local villages and villagers, site-specific information systems and expert systems;
- Provision of early warning systems about disease/pest problems, information regarding rural development programmes and crop insurances, post harvest technology;
- Facilitation of land records and online registration services;
- Services providing information to farmers regarding farm business and management;
- Increased efficiency and productivity of cooperative societies through communication networks and the latest database technology;
- Tele-education for farmers; and
- Online resources and dedicated website to be managed and updated by agricultural research institutes, making the latest information available to extension (knowledge) workers and obtaining their feedback.

The FAO report (1996) summarizes the above uses of the applications of ICT in support of agricultural and rural development into five main areas, as outlined below:

- Economic development of agricultural producers;
- Community development;
- Research and education;
- Small and medium enterprises development; and
- Media networks.

However, Shaik *et al.* (2004) note that for ICT to be beneficial in the provision of extension services and to be more diversified, more knowledge-intensive, and more demand driven, and thus more effective in meeting farmers' information needs, it has to move from focusing on what technology is in use to the quality of information and knowledge that really touches farmers' needs.

### 3.2.3 Processing Infrastructure

Barghouti *et al.* (2004) state that processing facilities are critical for improving market access, which has a positive effect on the capabilities of farmers in developing Third World countries in allowing them to compete with their counterparts in the developed countries. Many studies have also highlighted that poor post-harvest infrastructure is a major cause for the deteriorating performance of the agricultural industry (see for example, Ramaswamy, 1995; Kaul, 1997). Specifically, India is reported to be losing a substantial quantity (20-30% of the total harvest) of agricultural produce due to the lack of adequate infrastructure and post-harvest technology (see Singhal, 1995; Kaul, 1997; Viswanathan and Satyasai, 1997).

### 3.2.4 Agricultural Research and Extension Services

Barghouti *et al.* (2004) emphasize the importance of research to agricultural development. They suggest that research efforts are required in order to develop innovative solutions to new problems associated with alternative and unknown production enterprises and this would include diversification into the organic market.

The wider context of extension services, defined broadly as the rural knowledge and innovation system, has been recently reviewed by Alex, Zijp and Byerlee (2002), who argue that such services are the key to informing and influencing rural household decisions. Furthermore, Van der Ban and Hawkins (1996) pointed out that the objectives of agricultural extension services include the transferring of knowledge from researchers to farmers, advising farmers in their decision-making and educating farmers on how to enhance their decision making process. This enables farmers to clarify their own goals and possibilities and stimulates favourable agricultural development. Thus, Jones (1997) argues that agricultural extension, in the current scenario of a rapidly changing world, has been recognised as an elementary part of the transfer of knowledge and advice as an input for modern farming.

Furthermore, research and extension services also play an important role in generating technology. However, the weaknesses in research and the extension of its affects on the associations have limited the generation of new technologies (Gitu, 2004). In Iran, research shows that extension activities and training are the main determinants of farmers' perception and motivation, in organic farming among small farmers (Rezfanfar *et al.*, 2011 in Kafle, 2011).

The adoption of organic farming techniques may also be constrained by the lack of know-how. Therefore, the absence of training and extension facilities is considered one of the main obstacles to conversion to organic farming ( El-Akram,2001). Tress (2000) indicated that some farmers lack the professional knowledge necessary for conversion or are simply not interested in organic farming. In the Juru Communal area in Zimbabwe, organic farmers need technical and educational support to assist them in selecting materials and techniques that ensure the benefits of the organic methods are quickly realised (Svotwa *et al.*, 2009). Therefore, the availability of research and extension services are important in order to help farmers convert to an organic farming system.

### 3.2.5 Irrigation and Public Access to Water

According to Karasov (1982), the greatest challenge for agriculture is to develop technology for improving water use efficiency. This is underscored by a report by the Parliamentary Office of Science and Technology (2002) where it is argued that at the beginning of the twenty-first century, several countries suffered from increased water demand with serious challenges to alleviate the pressure on the water resources. This was because of the inefficiency of their agriculture management plans, the expansion of urban areas, and water contamination, all of which made the problem difficult to avoid.

The report adds that the UN Secretary General's report to the Millennium Assembly in September 2000 also highlighted water as an important issue and recommended that targets should be adopted for access to water. This same report also indicated that "world-wide irrigation was practiced on about 277 million hectares of land in 2003 with about 48 percent of the world irrigation in India, China, and the United States and 2 percent in Turkey. This shows that countries in Africa have little of their agricultural land areas under irrigation".

The importance of irrigation is stressed by Howeel (2001) who argues that irrigated farming is one of the most crucial elements of agriculture in general and particularly in providing fruit, vegetables, and cereal to meet the needs of people and livestock.

Addressing the issue of water supply, the Parliamentary Office of Science and Technology (2002) indicates that "water supply depends on several factors in the water cycle, including the rates of rainfall, evaporation, the use of water by plants (transpiration), and river and groundwater flows. It is estimated that less than one percent of all fresh water is available for people to use".

The remainder is locked up in ice sheets and glaciers. Globally, around 12,500 cubic kilometres ($km^3$) of water are considered available for human use on an annual basis. This amounts to about 6,600 cubic metres ($m^3$) per person/year (Parliamentary Office of Science and Technology, 2002).

Looking specifically at the case of developing countries, the Parliamentary Office of Science and Technology (2002) argues that access to adequate water supplies is most affected by the exhaustion of traditional sources, such as wells and seasonal rivers. Access may be worsened by cyclical shortages in times of drought, inefficient irrigation practices, and lack of resources to increase the efficiency of irrigation systems to meet the increasing demand. In many developing countries, farmers use double the amount of water per hectare to that of developed countries but the yield of the former is 3 times less than that of the latter. In addition, only one-third of all the water withdrawn for agriculture actually contributes to making crops grow. Some is returned to the system for reuse but much of it becomes unusable because of pollution.

A further issue in relation to water supply is the need for the water to be of an adequate quality that minimizes factors that affect health, such as water-borne diseases. Water pollution is caused by the use of detergents and harmful materials such as chemicals and industrial effluents. Furthermore, the cost of water treatment is high and many developing countries cannot afford it, leading to a scarcity of safe water.

Turning to the case of irrigation, Dunstan (1994) highlights that the "provision of irrigation systems was a fundamental factor that influenced the success of the Green Revolution in Asia". However, as Rosegrant and Perez (1997) point out, "inadequate growth in food production and increasingly scarce water poses serious constraints to future agricultural and economic development in Africa, particularly in Africa south of the Sahara". Many major crops benefit from the use of irrigation. As Rosegrant and Perez (1997) indicate that investment in irrigation is mainly affecting cereals such as rice, wheat, maize and other grains.

Ashok *et al.* (2006) found that irrigation plays a crucial role in increasing and stabilizing agricultural productivity. Venkatachalam (2003) points out that the introduction of technology such as sprinkler irrigation may lead to cropping pattern change that would move from those crops that cause soil erosion, to crops that may protect the soil. The secondary effects of soil erosion such as loss of fertility of the top soil are considerably reduced and this results in a reduction in the social costs or an increase in the social benefits of agriculture by reducing the exploitation of groundwater and making more of it available for downstream farmers.

In terms of funding irrigation, Requena and Hassan (2002) state that "many countries need The finance factor plays the important role in the annual investment of government budgets will often be the main source of funding. However, as government budgets might not be adequate, those countries may have the option of using public-private partnerships to attract additional financing".

### 3.2.6 Credit and Financial Institutions

Developments in agriculture depend on the efficiency of farmers. In order to enable farmers to increase production and adequately use modern agricultural inputs, it is necessary to provide credit on easy terms (Ahmed, 2007). Barghouti *et al.* (2004) indicate that the availability of credit significantly improves farmer' ability to venture into new lines of business, and enables them to make the necessary investments in the additional infrastructure required for these ventures. Khandker and Faruqeel (2003) provide evidence about this when they mention that there is a close positive correlation between institutional credit and agricultural output, consumption, and other household welfare indicators. Financial institutions are needed to provide access to credit and savings for farmers.

Where farmers lack access to finance, including credit constraints, such factors negatively influence plot size (Hazarika and Alwang, 2003), fertilizer use (Croppenstedt *et al.*, 2003), and total productivity (Freeman *et al.*, 1998). Furthermore they argue that lack of access to financial services reduce farmers' potential to make savings. The existence of long distances between farmers and banks increases costs and reduces access to credit required to stimulate production and investment in technology.

Diagne *et al.* (2002) add that access to the rural credit market is one of the most important indicators affecting famers' outcomes. Farmers in rural areas without adequate access to credit are believed to have a negative impact on technology adoption, agricultural productivity, food security, education and overall welfare.

Furthermore, the majority of financial institutions, particularly agricultural banks or rural banks have been established to support farmers and rural households and to provide credit at subsided interest rates. These banks have failed either to serve the rural poor or to become sustainable credit institutions (Adams, Graham and von Pischke, 1984; Guasch, 1986; Adams and Vogel, 1985). One of the reasons for the failure to serve the rural poor is highlighted by Ahmed (2007) who states that the shift of focus from the quality of the credit program into the accessibility of financial institutions leads to less participation in such programs.

## 3.3 Agricultural Infrastructure Accessibility

Agricultural infrastructure accessibility is a crucial factor for interaction between areas in economic, political and environmental terms. Therefore, information concerning agricultural infrastructure accessibility is relevant for informed decision-making, planning and research (RIVM, 2001). Researchers, to fit the purposes of their research, define accessibility differently, generally acknowledging the challenges in capturing all aspects of accessibility in one measure (Hodge 1997; Martín and Reggiani 2007). Thus there does not seem to be a commonly accepted definition for the concept of accessibility (Miller, 1999; Martín and Reggiani, 2007; Chang and Lee, 2008). They also point out that accessibility needs to be defined according to the specific objectives of each study. However, Chang and Lee define accessibility as the “potential of opportunities for spatial interaction”, whereas Nelson (2000) suggested earlier that accessibility could be “a central, integrating concept that grasps the complex interaction between subsistence and the economic and social needs of any population”. One way of approaching accessibility is to separate the concepts of place accessibility and agricultural infrastructure accessibility (see for example RIVM, 2001; Kwan and Weber, 2003, Weber, 2006). These researchers linked agricultural infrastructure accessibility to the level of ease of access to the farmers.

The National Bank for Agriculture and Rural Development (2004) in India highlights a number of benefits of agricultural infrastructural accessibility. It states that agricultural infrastructural accessibility has led farmers to reduce wastages and transportation costs, and to improve exposure to modern agriculture, and accessibility to suppliers, while linkages with the credit developmental institutions were found to favourably influence capital formation in agriculture, especially in the form of land development, irrigation wells, pump sets and farm machinery.

Accessibility has also helped in generating new employment opportunities among farmers. For example, the availability of roads leads to improved accessibility to input markets, reduction in transportation costs and increased frequency of visits of extension staff. Binswanger *et al.* (1989) note that "the effect of accessibility was greater for unimproved than for improved roads, suggesting that in bringing about socio-economic change, the existence of some kind of trafficable route is of major importance, [while] its quality is a second-order consideration".

Accessibility to agricultural infrastructure contributes directly to the growth of agricultural output, increased use of fertilizer and expansion of commercial bank operations. Raisuddin and Hossain (1990) highlight the ease of accessibility by farmers to the different agricultural infrastructures such as markets, banks, and extension services, which leads to improvement in several outputs such as agricultural production, household income, health, and the participation of women in the economy.

Thorat and Sirohi (2002) argue that " infrastructure such as transport, power, irrigation, tractorization, research, extension, access to primary agricultural credit societies, regulated and wholesale marketing infrastructure, access to fertilizer sale points and commercial banks, covering physical, financial and research infrastructure affect the development of agriculture. However, transport, power, irrigation and research infrastructure are four critical components, which affect agricultural productivity in a significant manner". They also note that between transport and power, “transport is a more dominant variable though there is a complimentary relationship between transport and power in the sense that accessibility to roads is normally followed by accessibility to power”.

With improvements in access to power, the irrigation infrastructure also improves through the provision of power supplies for the pumps. This in turn, improves irrigation facilities coupled with research input enhanced agricultural productivity. The development of transport infrastructure has a relationship with other infrastructural facilities such as access to fertilizer sale points, markets, credit and extension services. It also promotes accessibility to input markets, reduction in transport costs, and increased frequency of visits by extension staff of agriculture/horticultural departments to farms (Badatya and Nair, 2004). Thus, improved accessibility to transport infrastructure can help farmers improve their output and implement modern agricultural practices.

Apart from the importance of agricultural infrastructure to the development of agriculture, the environment-related issues play a major role in this development; these issues include deterioration of land, misuse of pesticides, and contamination of water sources. Chemical fertilizer and pesticide usage has increased over years, resulting in environmental implications. Thus, Pretty (1995) links these problems to each other and indicates that inappropriate use of agrochemicals can lead to the problem of contamination of water, loss of genetic diversity and deterioration of soil quality, which all have a direct effect on the environment and fertility of agricultural lands. Similarly, the consumption of agrochemicals can lead to human health problems (Harwood, 1990; Marquez *et al.*, 1992; Roll and Pingali, 1993). Overall, Tilman *et al.* (2002) argue that conventional agriculture not only significantly affects the environment, but is also impacted directly by changes in the environment.

Lynam and Herdt (1989) note that agricultural researchers should recognize the importance of the sustainability of agricultural systems and develop innovative practices. In relation to this suggestion, the following section examines the innovative concept of organic farming, its characteristics and prospects.

### 3.4 Organic Farming

According to Funtilana (1990), the variety of problems in the farming sector has generated several new concepts of farming such as organic farming, natural farming, biodynamic agriculture, do-nothing agriculture, and eco-farming. The main point of these practices is still the same; for example, back to nature, where the philosophy is to feed the soil rather than the crops, so as to preserve the soil, which means giving back to nature what has been taken from it.

Thus, sustaining the productivity of crops and maintaining soil health and a healthy ecosystem requires the adoption of alternative farming systems such as organic farming. Michelson (2001) argues that organic farming leads to extraordinary levels of production, and this is proved in developing countries. Thus, in the UK, Smith and Marsden (2003) reported a nine-fold increase in the area of land certified for organic production between 1996 and 2000. In contrast, Kaltoft (2001) argues that African agriculture is characterized by:

> "...a very low level of input use and the low take-up of green revolution technologies. Hence, it is sometimes claimed that most farming in Africa is already de facto organic. Because of the unsustainable way in which traditional agriculture, which is predominantly subsistence, becomes partially commercialized, the system evidently fails to meet food security needs or to protect fragile environments. However, where conversion to organic farming has been fully achieved, economic and viable yields are attained. The practical possibilities offered by the organic sector to supply

food untainted by agrichemicals, genetically-modified organisms and other 'unnatural' technologies provides compelling evidence of growing consumer and producer resistance to the risks they associate with agri-industrial production methods".

### 3.4.1 Organic Farming Definitions and Concepts

Parrott *et al.* (2006) note that agro-ecological approaches such as organic farming can address a number of concerns. These approaches resonate with and are being used in initiatives designed to:

- Ensure food security;
- Eradicate poverty;
- Maintain and enhance soil fertility;
- Combat desertification;
- Promote tree-planting and agro forestry;
- Develop low and no input means of combating pests;
- Promote the use of local seed varieties;
- Maintain and enhance biodiversity;
- Support the most vulnerable social groups (often particularly women and households headed by women); and
- Combat global warming.

The concept of organic farming has been of interest for some time now, and there are numerous definitions. According to Lampkin (1990), organic farming is a production system which avoids or largely excludes the use of synthetically compounded fertilizers, growth regulators and live stock feed additives. According to Funtilana (1990), organic farming is not merely non-chemicalism in agriculture; it is a system of farming based on integral relationships. Again, he defines organic farming as a form of agriculture, which does not use chemical inputs in its production process, but enhances the biological and ecological processes to promote soil fertility and good health of animals and plants. It involves a holistic view of food production that relies on ecological processes, biodiversity and cycles adapted to local conditions rather than the use of external inputs with adverse effects.

IFOAM (2004) notes that organic agriculture is a production system that sustains the health of soils, ecosystems, biodiversity, and of people. It relies on ecological processes and nutrient cycles adapted to local conditions, rather than the use of external inputs with adverse effects. Organic agriculture combines traditional knowledge, innovation and modern science to benefit the shared environment and promote fair relationships and a good quality of life for all involved. Such an approach is showing itself to be a viable sustainable development option for Africa. The organic farming system emphasizes management over technology, and biological relations and natural processes, over chemically intensive methods".

Twarog and Kapoor (2004) argue that "Organic farming in Africa must be viewed beyond the perspective of providing commodities for the global market. Rather it should be seen as an agricultural system that 'enhances' and 'manages' the complexity of the ecosystem rather than reducing and simplifying the biophysical interactions on which agricultural production depends".

It consciously integrates and takes advantage of naturally occurring beneficial interactions and the rich layers of indigenous knowledge. According to IFOAM (2004), the four basic principles of organic farming are:

- The principle of health: organic farming should sustain and enhance the health of the soil, plant, animal and human as one and indivisible;
- The principle of ecology: organic farming should be based on living ecological systems and cycles, work with, emulate them, and sustain them;
- The principle of fairness: organic farming should build on relationships that ensure fairness at all levels and to all parties - farmers, workers, processors, distributors, traders and consumers;
- The principle of care: organic farming should be managed in a precautionary and responsible manner to protect the health and well-being of current and future generations and the environment.

The organic farming system is designed to maintain healthy and fertile soil in the long term, through creating a process of crop residues, animal manures, legumes, green manures, off farm organic wastes, and aspects of biological pest balancing. Also organic farming relies on the recycling of wastes and replenishment of the nutrients depleted from the soil during the crop growth, encouraging the growth of microorganisms. The latter regulates the phased release of stored nutrients in the soil to the crop growth in the right proportion, maintaining soil health by balancing the soil moisture and soil aeration and ensuring soil fertility by firmly binding the nutrient elements in the complex organic molecules.

The concept of organic farming hinges on the concept of sustainability; the relationship between soil, water, plant and micro-flora and the overall relationship between the plant and animal kingdom. It is the totality of these relationships which is the backbone of the organic farming (Funtilana, 1990).

Ikerd (1997) points out that the concept of sustainability is a comprehensive concept with three dimensions: economic, ecological and social. Thus to be sustainable, agriculture has to be economically viable, ecologically sound, and socially responsible.

Therefore, sustainable agriculture is defined as the ability of farming systems to maintain their productivity and usefulness to society in the long-term. This means that sustainable agriculture includes both the long-term viability of the farming system itself and the contribution of this farming system to the sustainability of the territory and the communities to which it belongs (Hansen and Jones, 1996; Godard and Hubert, 2002; Gafsi, 2006).

### 3.4.2 Organic Food and the Consumer

According to IFOAM (2006), more than 1 million hectares are now managed and certified organic globally. Additionally, 6.8 million hectares are certified as forest and 'wild' harvested areas. However, despite the fact that more than 435,000 hectares and 118,000 farms are now managed and certified organic, the global market of organic food is shared by Europe (54%), North America (43%), and then other countries (3%) (IFOAM, 2006). This result therefore shows that consumer demand for organic products is concentrated in North America and Europe, and these two regions comprise 97 percent of global revenues. In addition, these areas are the largest markets for organic products, and many products are imported. Therefore, the countries with the largest markets are the United States, followed by Germany and the UK, while other parts of the world, such as the countries of Asia, Latin America and Australasia are important producers and exporters of organic foods.

However, the African market for organic produce is still very small and insufficient. This is due to many reasons such as low-income levels and also an undeveloped infrastructure for inspection and certification (IFOAM, 2006). In Libya, the agricultural market is still not as developed as in European countries and is still insufficient. Moreover, there is no organic market yet in the country due to the limitation of organic commodities produced in the country. Despite the limitations of produce, however, there are some organic food commodities in rural areas and in the desert, but all the commodities produced in Libya that are known as organic are still not certified as such. The Research Institute of Organic Agriculture (FiBL, 2006) has indicated that the global market for organic products in 2008 is as presented in Table 3.1.

**Table 3.1 Global Market for Organic Products for 2008**

| Country | Turnover in million Euros |
|---|---:|
| USA | 16,000 |
| Germany | 5,850 |
| UK | 2,639 |
| France | 2,600 |
| Italy | 1,970 |
| Canada (2007) | 1,126 |
| Switzerland | 911 |
| Austria | 810 |
| Spain (2007) | 600 |
| Denmark (2007) | 580 |

Source: IFOAM (2006) & FiBL (2006)

In 2007 almost 0.9 million hectares about 3 percent of the world's organic agriculture land were certified organic. However, most African countries, such as Tunisia, Morocco and South Africa, produce organic food to export it to international markets (IFOAM, 2009; FiBL 2009).

A worldwide increase or decrease in the consumption of organic food depends on consumers and markets. The consumption of organic food is determined by many factors; for instance, Lohr (1998) states that taste, freshness, quality and food safety concerns drive consumer demand for organic food, and price premiums, the price-quality trade-offs, as well as the country of origin and other social concerns will most likely determine future market expansion. Furthermore, a number of surveys have been carried out worldwide such as DMB&B, 1986; Fallows and Gosden,1986; Presto, 1986; MAFF,1987; and NOP,1987. All of these surveys pointed out that there are three important areas of consumer concern with regard to food consumption (Lampkin, 2002). These important areas are:

1- The healthiness of food in general is now a significant attribute contributing to the consumer perception of quality of diet.

2- There is concern over the risks of contamination of food by residues of agrochemicals.

3- There is a widespread concern over the quality of the environment and the negative impact of modern agricultural systems on the countryside.

Therefore, there is undoubtedly concern about the health attributes of food and environmental issues as well. Thus it is notable that the growth of the organic food market has been remarkable during the last few decades, as well as the fact that consumer demand has increased epically in developed countries such as the US, Germany, France, the UK and Italy (see Table 3.1).

The awareness of consuming organic food depends on the information and knowledge that consumers have, as mentioned by the Director of Technical Centre for Organic Agriculture, in Tunisia, Professor Ben Khedher , with whom the researcher conducted an interview, during the early stages of this research. Professor Ben Khedher stated that *"low awareness of consuming organic food in Tunisia is due to a lack of information and knowledge"* (Wali, 2006).

Therefore, to increase the level of awareness is most important, and this could be achieved through the media and through the education curriculum system, as a method to encourage the consumer to choose organic produce.

He added that "*in Tunisia, the main goal of producing organic food is to export it abroad, so the customer awareness of consuming organic food in Tunisia is still low, but the government is trying to increase the level of awareness gradually*" (Wali, 2006). The interviewee agreed that the reason behind the growth in organic farming and the production of organic food in Africa and Tunisia is because of the increasing demand for organic food in developed countries. Therefore, most of Africa's countries, such as Tunisia, Morocco and South Africa, are producing organic food so as to export it to international markets (IFOAM and FiBL 2009). However, in Libya, the lack of awareness about organic food, which is due to the lack of information about the organic farming movement, has led to under-development of the organic agricultural sector. The Tunisian lesson is that Tunisian agricultural organic food products are exported to the markets of many countries, such as Italy, France, Canada, Australia and America, and yet the Tunisian organic food market is still insufficient (Wali, 2006). Therefore, as Ben Khedher pointed out, there is a need to develop the awareness of people in Libya, relevant to the development of the organic market (Wali, 2006). Furthermore, Ben Khedher and Nabil (2004) indicted that there is not yet a real local market for organic products. Therefore, a strategic polices were taken to encourage local consumption and marketing.

However, in Africa, organic farming production is facing challenges, one of which is organic food certification. Rundgren (2006) indicates that certification has been a very important tool for the development of the organic market. Through certification, organic products are given a distinct credible image, which is particularly useful in a marketing situation with a distance between producer and consumer. IFOAM (2006) states that in Africa, organic production is rarely certified, and for many countries new figures were not available. In addition, the increasing growth of organic farming in Africa is due to the demand for organic food in the industrialized countries, besides stakeholders' motivation to maintain and build soil fertility on land threatened by degradation and erosion

(IFOAM, 2006). See Table 3.2 for the distribution of organic certification bodies from 2003-2005 worldwide.

**Table 3.2 Organic Certification Bodies from 2003 - 2005 Worldwide**

| Contents | Number of Organic Certification Bodies | | |
|---|---|---|---|
| | 2003 | 2004 | 2005 |
| Africa | 7 | 9 | 7 |
| Asia | 83 | 91 | 117 |
| Europe | 130 | 142 | 157 |
| Latin America and Caribbean | 33 | 33 | 43 |
| North America | 101 | 97 | 84 |
| Oceania | 10 | 11 | 11 |

Source: CPTF (2006)

Table 3.2 shows that over the years 2003-2005, Africa has a lowest number of organic certification bodies, whereas Europe has the largest number of certification bodies in the world.

Even though organic food certification still presents a challenge to the development of organic farming in Africa, there are many countries, such as Tunisia, Egypt and South Africa, who are meeting these challenges and going beyond them. Tunisia, for example, is not facing a problem of organic certification because it has built a good certification body for organic products. This has been achieved by setting a national regulation about organic farming. Therefore, the relevant legislation in Tunisia is based on the IFOAM basic guidelines and Tunisian regulations. In addition, Tunisia has 3 organizations that provided organic certification, while Egypt has 9 certification bodies certifying the majority of producers. In contrast, countries such as Libya do not have certification bodies despite the availability of some organic products in rural and desert areas, such as dates, herbs, olive and organic meat from such animals as camels, gazelles, goats and sheep (including aoudad) .

The other issue in organic growth is the development of the available market, which is vital in order to develop organic farming consumption. The market plays a major role in attracting people and offering the product in the right way, using marketing techniques to attract consumers to organic food and contain the products in healthy way. Research in Europe has established 6 critical conditions for the development of organic markets (Rundgren ,2006), which are:

- Strong consumer demand;

- High degree of involvement by food companies;

- Sales through conventional supermarkets;

- Moderate (less than 50 percent) organic price premiums;

- One dominating label; and

- Nationwide professional promotion.

In accordance with the findings of this study, the researcher will address in Chapters 7 and 8 the important development required to develop an organic farming approach in Libya.

### 3.4.3 Characteristics of Organic Farming Systems

Padel and Lampkin (1994) argue that the management of organic farming is focused on the whole farm system and its interactions with climate, environment and social as well as economic conditions. The key characteristics of organic farming are:

- Protecting the long-term fertility of soils by maintaining organic matter levels, soil biological activity and careful mechanical intervention;
- Nitrogen self-sufficiency through the use of legumes and biological nitrogen fixation, as well as effective recycling of organic materials, including crop residues and livestock wastes;

- Weed, disease and pest control relying primarily on crop rotation, natural predators, crop diversity, organic manuring, use of resistant varieties and limited thermal, biological and chemical intervention;
- Supplementing crop nutrients, where necessary, by using nutrient sources which are made available to the plants indirectly by the action of soil micro organisms and chemical reactions of the soil;
- The extensive management of livestock, giving full regard to their evolutionary adaptations and behavioural needs, and animal welfare issues with respect to nutrition, housing, health, breeding and rearing; and
- Careful attention to the impact of the farming system on the wider environment and the conservation of wildlife and natural habitats.

### 3.4.4 Socio-Economic Factors and Organic Farming Development

No doubt socio-economic factors such as gender, age, level of education, experience, farm size, and level of personal income play a role in organic farming practices (Adesope *et al.*, 2008). The researcher is focusing on characterising conventional and organic farms and their farms so as to understand the role of these factors in facilitating the conversion to organic farming in Libya and other countries, and also to develop agricultural policies in general and to adopt best practices which could play a vital role in developing the organic farming sector as well as developing the agricultural infrastructure in the country. Therefore, the decision by farmers to convert to organic farming may be influenced by the general information that they acquire about this, and increase the likelihood of their adopting the new technology. Farmers' information-gathering is expected to enhance resource allocation skills and to increase the efficiency of adoption decisions (Genius et al., 2006). Therefore, farmers with a high level of resource allocation skills will make more accurate predictions of future yields and profitability, and thus will make more efficient adoption decisions (Just and Zilberman, 1983).

Several researches indicate that the role of the human capital theory, and innovative characteristics ability, which is dependent on education level, experience and information accumulation, were associated with the resource allocation skills of farm operators (Schultz, 1972; Huffman, 1977; Rahm and Huffman, 1984). Therefore, analyzing the socio-economic status of farmers and farms researched in this study is important so as to help understand the development of organic farming in other countries in relation to the transformation to organic farming in Libya. Studies such as Fairweather (1999) and Midmore *et al.* (2001) attempt to characterise and quantify the number of conventional farmers considering a conversion to organic farming. Furthermore, the role of the various driving forces at the farm level is crucial to understanding and promoting the adoption of organic farming methods. This is because transformation is a complex innovation that requires a strategic or system change on the part of the farmer (Padel, 2001).

For this study, focusing on the above-mentioned factors is vital, in order to understand the capacity of farmers who are linked with organic farming which has been proved to be effective for enhanced adaptive capacity of farmers. The analyses of these variables are necessary since they influence agricultural development. The following section summarises some of the researcher's findings about socio-economic factors and their role in the conversion to organic farming as well as in agricultural development.

#### 3.4.4.1 Age

The conditions of age are always linked with to what extent farmers can physically operate the farm, and physical difficulties may prevent older farmers from converting to organic farming, which is considered as a labour intensive system (Fasterding and Rixen, 2006; Trauger *et al.*, 2008). It can also be argued that age is associated with a farmer's decision as to whether or not to convert to organic farming, considering the risk of transformation to organic. Furthermore it was found that age plays an important role in the farmers' attitude to the transformation to organic farming. Tress (2003) found that in the county of Ribe in Denmark, the percentage of farmers with a positive attitude towards conversion was highest among farmers less than 40 years old.

Many studies such as that by Lockeretz (1995) found that in Massachusetts, USA , organic farmers were younger than non-organic farmers. In addition, the UK's Association (2006) findings support the USA findings.

### 3.4.4.2 Level of Education

The level of farmers' education determines their ability to interpret information. Therefore, people with higher educational levels are more able to interpret information than those who have less education or no education all (Mather and Adelzadeh, 1998). Thus, education levels affect the use of agricultural information and the implementation of agricultural practices. Innovation theory states that innovators are better educated than later adopters and tend to have more social contacts outside their local community (Padel, 2001; Rogers; 1983). In addition, Shultz (1964; 1975) states that education is thought to be most important to farm production in a rapidly changing technological or economic environment. In developing countries, a link between education and agricultural output is supported by ample evidence from developing world literature. Hussain and Byerlee (1995) note that evidence is mounting (for Asia at least) that returns to schooling in agriculture may be as high as for urban wage earners.

On the other hand, some studies conducted in Africa found that education was not a significant factor in output. Appleton and Balihuta (1996) point out that these surveys included only two African studies, which were conducted in Kenya, where it was found that education was not significant. However, the effect of schooling on agricultural output is usually not significant in several additional African studies. Anim (1999) found that more educated farmers tended to adopt organic farming methods more quickly than those who were less educated. Furthermore, several studies from other countries have reported organic farmers to be better educated than their conventional counterparts (Padel, 2001).

### 3.4.4.3 Farmers' Experience

Studied conducted in 2008 in Norway found that the average of organic farmer experience was nearly 22 years of farming experience, whereas the average conventional farmers' experience was 25 years ( Matthias *et al*, 2008). Another study, carried out in Nigeria, showed that 56.7% of the organic farmer respondents had 6 to 10 years' farming experience ( Adesope *et al.*, 2008)

**3.4.4.4 Farm Size**

Margulies (1985) argues that farm size, whether large or small, has no absolute meaning but varies with the soil types and crops cultivated. Many studies have indicated that farmers who own a large farm are more concerned about the risk in conversion to organic than farmers who own a small farm. Therefore it was found that farmers with a large scale of farm size were afraid, and saw difficulties in implementing organic methods on a large-sized farm (Egri, 1999).

Several studies also pointed out that the average farm size of organic farms in most countries was smaller than conventional farms (for instance, United States: Harris *et al.*1980; Lockeretz and Anderson, 1990; Denmark: Dubgaard and Soerensen 1988; Canada: Henning *et al.,* 1991). Furthermore, some studies found that organic farmers have smaller farms, and tend to be younger and better educated, often from an urban background and with less farming experience than their conventional counterparts (Lockeretz, 1997; Padel, 2001). Murphy (1992) found that 43% of organic farms in England and Wales were under 5 ha and that 40% of these farms were horticulture farming. However, some older studies, in Germany and one from the USA, found that the organic farms were larger than conventional farms ( Boeckenhoff *et al.*,1986; Dabbert 1990b; Wernick and Lockeretz, 1977 in Padel 2001). Furthermore, a study conducted in South Africa found that most of the farms converted in South Africa were horticultural holdings and smaller than the average commercial farms (Niemeyer and Lombard, 2003).

**3.4.4.5 Ownership**

Ownership is considered as a relationship between people and the land, and this relationship between people and their assets is always associated with social, political and economic problems (Yalcin, 2011). Ownership, the right to own, means being able to use the real estate within the framework of the laws however that person wants (Yalcin, 2011).

The availability of agricultural related assets influences production and marketing decisions among smallholder farmers (Stroebel, 2004). This means that farmers who own their farms have a direct influence on what to produce and where to market their produce, unlike those who do not own their farms. This also indicates that farmers who own their farms have options to make decisions related to agricultural activities, again unlike those who do not own their farms. Furthermore, the Soil Association in the UK (Crucefix, 1998) indicated that If farmers do not have a good title to their land, many are reluctant to plant permanent crops. Getting a good title for reservation land is a long and complicated process. In addition, Ben Khedher (2001) indicates that ownership is one of the main practical obstacles and constraints to conversion in Mediterranean countries. Therefore, uncertainties about ownership and access to land are real obstacles to conversion.

#### 3.4.4.6 Number of Farm Managers

Labour is important to the production process, and can be an impediment to the adoption of organic agriculture. Compared to large-scale mechanized agricultural systems, organic farming appears more labour intensive. Many techniques used in organic farming require significant labour (such as strip farming, non-chemical weeding, and composting), and in the some countries, labour scarcity and costs may deter farmers from adopting organic systems ( Ortiz and Hue, 2007).Furthermore, Isikli (NA) states that labour use in organic farming is higher than conventional agriculture. Increasing of labour number in organic due to the developed of new marketing and processing activates, rather than to increase in labour use for specific crop and livestock enterprises.

#### 3.4.4.7 Annual Turnover

Organic farming is economically profitable compared to other possible activates Isikli (2002), and it also economically profitable if returns to the production factors used exceeds their opportunity cost (Offermann and Nyberg , 2000).

### 3.4.5 Prospects for Organic Farming: Opportunities and Challenges

In developed economies such as France, organic farming has experienced considerable development. Between 1995 and 2008, the number of organic farms and the area under organic farming increased fourfold. Furthermore, in the same period, food processing and marketing companies using an organic label had grown from 700 to 7,398 globally (Bio, 2009). This, combined with the fact that organic produced is often an 'added value' commodity, suggests that there is potential for growth in a North African scenario too.

There are two levels of organic farming in Africa: certified organic production and non-certified or agro-ecological farming. Certified production is mostly geared to products destined for export beyond Africa's shores. African agriculture is characterized by a very low level of input use and the low take-up of green revolution technologies. Nevertheless, Parrott *et al.* (2006) argue that

> "Because of the unsustainable way in which traditional agriculture, which is predominantly subsistence, becomes partially commercialized, the system evidently fails to meet food security needs or to protect fragile environments. However, where conversion to organic farming has been fully achieved, economic and viable yields are attained".

In conclusion, the use of organic sources is feasible if the focus is on production of high quality healthy farming output. Thus, it is more directed towards quality rather than quantity of production.

### 3.4.6 Organic Farming Concerns

Organic farming development in Libya has to focus on issues: first, for the environment, which focus on the quality and balanced use of fertilizers and pesticides, second, for the social, which focuses mainly on the major effects of organic farming on health. These two points are discussed in detail in this section.

#### 3.4.6.1 Environmental Cconcerns'

Environmental concerns are one of the most important reasons for establishing organic farming in Libya and other countries. Therefore, in Tunis environmental concern is one of the leading factors for converting to an organic farming system and it motivates farmers to convert to organic farming. This is supported by Professor Ben Khedher, the Director of the Technical Centre for Organic agriculture in Tunis, who states that:

> "*There is a belief among some farmers in Tunisia that maintaining the environment and soil is very important in order to retain this wealth for the next generations. We also have important procedures which are necessary when registering any biological or chemical elements, while we observe in our own countries, such as Saudi Arabia, they are not concerned about registering. I believe these procedures protect the environment*" (Wali, 2006).

This follows the pattern that has emerged in developed western economies, in which farmers' and consumers' demands for environmental and health quality created the organic agriculture movement (Thompson, 1998). A variety of agricultural enterprises have been developed across Libya with private farms using industrial agricultural techniques to increase national productivity. Nevertheless, a number of problems have emerged, including that of the environment.

Many Libyan agricultural enterprises depend on modern farming practices which include the intensive use of fertilizers and pesticides. These practices have led to the contamination of underground water, soil degradation and other serious environmental pollution (Aljandeal, 1978). Al-Arbah (1996) explains that the lack of awareness of problems associated with the use of chemical fertilizers and pesticides has directly affected the control of parasites, which play an important role in the environmental balance. In addition, chemical pesticides reduce the amount of agricultural yield because of the degradation of soil fertility. As Al-Arbah (1996) states, the residues of pesticides in soil have resulted in reduced seed growth, which is exacerbating desertification. Millstone and Lang (2002) indicate that agricultural biodiversity includes not only the animals and plants used for food, but also the diversity of species that support food production. This is particularly so for micro-organisms in the soil, pest-predators, crop pollinators, and the wider environment within which the agricultural ecosystem is located. They also note that organic composts could also increase yields dramatically. A project in Brazil, for example, demonstrated that the use of green manures and cover crops could increase yields by 250%.

One of the most serious environmental problems in Libya is desertification, which is the degradation of drylands, and causes 10% depletion of ground water, salinization of soil by 10% and degradation of soil by 10% for the recent years (AOAD, 2009).

The environmental problems created by conventional mass production farming methods in Libya have led the Libyan People's Congresses to identify the environmental impacts as very serious. As a result, in order to minimize the adverse effects of agriculture on the environment, policies have been put in place relating to water resources, waste and refuse management, and control of the use of pesticides and the level of chemicals in foodstuffs (Libyan Environmental Magazine, 2005). Nevertheless, the Libyan General Environment Authority (2002) pointed out that there was an increase in the volumes of chemical materials and agricultural pesticides used between 1987 and 2001. This is an indication that there was an extensive use of synthesized chemicals in the Libyan agricultural system that could affect human health and the environment.

These trends are important in developing an understanding of the way in which conventional farming in Libya has become dependent on synthetic chemical inputs and how organic farming practices can be used to improve the environment.

#### 3.4.6.2 Social Concerns

Several studies (see for example, Rehber and Turhan, 2002; Al-Arbah, 1996) conclude that social concerns about health and the impact on nature are one of the most important motivations for establishing organic farming systems. These studies suggest that organic farming has been developed in many Western countries because of the awareness of society about the potentially hazardous effects of the highly industrialised, conventional agricultural system, on the health of human beings and on nature. Al-Arbah (1996) indicates that whilst the application of synthetic chemical pesticides helps to control pests and diseases, it is also the case that many of these pesticides are harmful to human health and to animals. The use of inorganic fertilizers causes pollution to ground water and soil and affects non-target animals.

Worldwide, the rise in the rate of cancer disease due to pesticides has become one of the most important concerns for people's health. The Environmental Protection Agency in the United State (2004) estimates that 10,000-20,000 physician-diagnosed pesticide poisonings occur each year among approximately 3,380,000 U.S. agricultural workers (Hanson *et al.*, 2004). Furthermore, epidemiological studies of cancer in the USA suggest that farmers in many countries, including the United States, have higher rates than the general population for Hodgkin's disease, leukaemia, multiple myeloma, non-Hodgkin's lymphoma, and cancers of the lip, stomach, prostate, skin, brain, and connective tissue (Hanson *et al.*, 2004 ).

Additives in the food supply and processing chains are also a cause for concern. Millstone and Lang (2002) indicate that the food industry in USA spent around $20 billion in 2000 on chemical food additives to improve the colour, flavour, texture and shelf-life of its products. They stated that around 540 food additive compounds are deemed by regulatory bodies as safe for human consumption, but assessments of the testing systems have raised doubts about many of these substances. Najdee (2006) notes a range of opinions regarding the dangers of additives. One view is that almost all the additives cause health problems and should not be used at all. Others suggest that additives can affect health, but that they can still be used to preserve food or to make it more acceptable to consumers.

As a result of these factors, Millstone and Lang (2002) state that consumer demand for organic produce in the industrialized world is growing steadily. There is an increased awareness of health and environment issues. With higher disposable incomes, people can make lifestyle choices such as paying more for food they feel will be better for them and less damaging to the environment. For example, public concerns about 'mad cow disease' in the UK and other countries in Europe increased the demand for organic meat and milk (Millstone and Lang, 2002). Najde (2006) indicates that in 1980, around the world, about 5 million children died because of food polluted by chemical pollution. The effects of environmental problems can be seen in the increasing rates of disease (such as liver cancer). These issues are promoting the advancement of farming systems towards organic practices.

## 3.5 Food Security

Food security exists because people require physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (World Food Summit, 1996). The World Bank similarly defines food security as access by all people at all times to enough food for an active, healthy life. The essential elements are the availability of food and the ability to acquire it (World Bank, 1986).

Huddeston (1990) pointed out that the Food and Agriculture Organization of the United Nations states that the main goal of food security is to ensure physical and economic accessibility to the essential food needs for all people at all times. The European Community also defines food security as the absence of hunger and malnutrition (Kennes, 1990). Maxwell (1990) reviews these and other definitions and suggests that a country and people are food secure when their food system operates efficiently in such a way as to remove the fear that there will not be enough to eat.

Food security has become a major issue for Libya with its growing urban population, its vulnerable environment in terms of climate change, and especially the period of international sanctions during the late twentieth century. It was these issues that drove the push for intensive and petro-chemically resourced farming, which have resulted in the growing environmental and health problems.

Policymakers in most European Union countries seem to agree that "organic farming should play a crucial role to draw the future of European agriculture, and in many cases, make land area targets to transform to organic farming in the next 5–10 years (Willer and Yussefi, 2002). In a similar vein, organic farming practices have the potential to ensure food security in Africa and the world.

## 3.6 Summary

There is growing interest in the role of infrastructure (widely defined) because it is considered one of the major issues for agricultural development. Infrastructure is recognized to play a vital role in agricultural development, and Wanmali and Islam (1995) note that there is a positive relationship between availability to and accessibility of infrastructure and agricultural growth. This would be the case with organic agriculture as well. The presence of technology in agriculture, which has an important strategic role in agriculture growth, depends heavily on both physical and institutional infrastructure (Mellor, 1976).

Majumdar (2002) suggests that of the various physical infrastructures, transport most significantly affects agricultural output and the agricultural development index. The availability of and accessibility to agricultural infrastructure and services lowers agricultural production costs by reducing wastage and transportation costs, gaining better exposure to improved or modern agro-practices, improved accessibility to input markets, improved road access to farms and farmers, and linkages with the credit/developmental institutions. In addition, agricultural infrastructural availability and accessibility have favourable influences on capital formation in agriculture, particularly in relation to land development, irrigation systems and farm machinery. This helps to generate new employment opportunities.

Under-served communities in terms of agricultural infrastructure suffer higher levels of risks and uncertainty in their production and marketing endeavours, and apparently they tend to be more risk averse, because of the lack of growth (Temu *et al.*, 2003). The provision of effective infrastructure to facilitate efficient moderation therefore becomes imperative, especially for developing countries in Africa. Despite, the importance of agricultural infrastructure to the development of agriculture, environmental problems such as deterioration of land and contamination of water sources by agrochemical use have raised social concerns.

The chapter has reviewed the literature on agricultural infrastructure and organic farming in order to achieve the aim of this research, which is to critically examine how infrastructure might facilitate the development of organic farming in Libya. The understanding gained from the literature review will help in developing the relationship between the research findings presented in Chapter 5 and the literature reviewed. This will help to answer the research question

"Does the successful development of organic farming in Libya depend on the adaptability of the existing infrastructure?"

# CHAPTER FOUR

## RESEARCH METHODOLOGY AND DESIGN

### 4.0 Introduction

This chapter discusses the methodology used for collecting and analysing data for the research on the importance of agricultural infrastructure for the transformation to organic farming in Libya. Adam and Haley (2002) stated that research methodology is the overall approach taken to investigate an issue of concern and it covers the research methods and tools used to achieve the given research objectives. Zickmund (2000) defines research methodology as the procedures for collecting and analysing the required information on a research issue.

This chapter is divided into sections. These sections present the preparatory phase of developing the strategy of the research including selection of research methods and the locations of the field study and sampling strategy. Other sections describe the research methods used in collecting data as well as techniques used for analysing and interpreting the data. The concluding sections are on the validity, reliability and limitations of the methods used in the research.

### 4.1 The scope

The research concerns the availability of agricultural infrastructure and its role in agricultural development in Libya. It considers how the existing agricultural infrastructure can lead to the transformation to organic farming systems and how the use of agricultural inputs is affected by the infrastructure in Libya. Accessibility is one of the main factors of this study to understand how it assists the agriculture sector across the country. The research also explores the role of agricultural infrastructure and the extent to which it facilitates the implementation of the principles of organic farming.

## 4.2 Research Questions/Hypothesis

Research questions are answered through the application of research methods selected by the researcher. The methodological stance of a researcher can influence the results of a study. Research questions are usually developed as a tool for exploring the research work and help to determine what is achievable within the framework of the research (Bryman, 2004; Sarantakos, 2001 and Punch, 2005). Developing research questions for this research, the researcher focused on the role that research questions play in achieving research objectives. The research questions were developed to give direction and coherence to the research method and the design to be employed. They were used to set the boundaries for the research and to indicate how research data that is needed is to be collected.

In order to achieve the research objectives as stated in Chapter 1, the following research questions have been developed to focus the study and to establish a systematic methodology to gather research information.

The main research question is:

1. Does the successful development of organic farming in Libya depend on the adaptability of the existing infrastructure?

The subsidiary research questions are:

2. Does the current Libyan agricultural infrastructure meet the needs for the establishment of organic farming?
3. How should the infrastructure be developed to facilitate the growth of organic agriculture in Libya?
4. Based on a competitive study of organic farming in the Mediterranean countries, what approaches to organic farming are transferable to Libya?
5. To what extent is the current infrastructure of Libyan agriculture appropriate for such conversion?
6. How does the process of conversion to organic farming in Libya relate speciality to peculiarities of farming in that country?

The main hypotheses that underpin this research project are:

1. It is suggested that current policies, structures and infrastructure in Libyan agriculture do not favour organic systems.

2. Successful development of organic agriculture in Libya will depend on the adaptability and flexibility of the current systems of support.

3. It is suggested that if current support is inadequate, the successful development of organic farming in Libya will depend on the adaptability of existing infrastructures.

### 4.3 Research Philosophy

Philosophers of science and methodologists have been engaged in long-standing epistemological and ontological debate about how best to conduct research. According to Amaratunga *et al.* (2002), this debate has centred on the relative values of two fundamentally different and competing schools of thought or inquiry paradigms:

1. Logical positivism uses quantitative and experimental methods to test hypothetical-deductive generalisations.
2. Phenomenological (interpretive science) inquiry uses qualitative and naturalistic approaches in order to understand human experience inductively and holistically in the context-specific settings.

Baer (1979) stated that a philosophical system underpins the choice of a methodology. Qualitative and quantitative methods are derived from entirely different perspectives of philosophical paradigm (positivism and phenomenology); the researcher should therefore have a clear understanding of the inherent differences between them. These are outlined in Table 4.1 below.

**Table 4.1 Characteristic of Philosophical Paradigms**

| Positivism | Phenomenology |
|---|---|
| Outside observer; separate from phenomena | Intertwines observer and phenomena |
| Seeks causal relationship | Many different but equal truths dependent upon the purpose of the researcher |
| Seeks truth in order to explain a phenomenon of interest | Seeks understanding of the meaning of the phenomena of interest |
| Quantitative; context stripping assumptions and methodologies | Qualitative; holistic analysis |
| Increased reliability | Increased validity |

Source: Adapted from Shih (1998).

A critical appraisal of the relevant literature was undertaken in Chapters 2 and 3 in order to develop a framework for this research (Spencer *et al.* 2003). Several researchers have used different approaches in developing research frameworks (Sapsford, 1999; Frankfort *et al.*, 1996 and Bryman, 2004). The conceptual framework for this research is aimed to triangulate appropriate methodologies, both quantitative and qualitative, in order to address critical issues on the importance of agricultural infrastructure in the potential transformation to organic farming in Libya. The research framework has been developed to position the investigation and give it direction and focus in exploring the research questions.

## 4.4 Research Strategy

There are two distinct types of approaches to research: qualitative and quantitative. According to Amaratunga *el al.* (2002), qualitative approach concentrates on words and observations to express reality and attempts to describe people in natural situations. However, the quantitative approach places emphasis on numbers to represent opinions or concepts. Some differences between the two approaches are shown in Table 4.2 below.

**Table 4.2 The Differences Between Qualitative and Quantitative Research**

| Qualitative paradigms | Quantitative paradigms |
|---|---|
| Concerned with understanding behaviour from actor's own frames of reference | Seek the facts /causes of social phenomena |
| Naturalistic and uncontrolled observation | Obtrusive and controlled measurement |
| Subjective | Objective |
| Close to the data: the 'insider' perspective | Removed from the data: the 'outsider' perspective |
| Grounded, discovery-oriented, exploratory, expansionist, descriptive, inductive | Undergrounded, verification-oriented, reductionist, inferential and hypothetico-deductive |
| Process- oriented | Outcome oriented |
| Valid: " real", " rich" and " deep" data | Reliable: " hard" and replicable data |
| Ungeneralizable : single case studies | Generalizable: multiple case studies |
| Holistic | Particularistic |
| Assume a dynamic reality | Assume a stable reality |

Source: Blaxter *et al.* (2003, p.56). Adapted from Oakley (1999, p.1560)

The following similarities between qualitative and quantitative research were identified by Blaxter *et al.* (2003):

1. Quantitative research may be mostly used for theory testing but it can also be used for exploring an area and generating hypotheses and theory.

2. Even though qualitative research is mostly used for theory generation it can be used for testing hypotheses and theories.

3. Qualitative data often include quantification (e.g. statements such as 'more than', 'less than', 'most', as well as specific numbers).

4. Quantitative approaches can collect qualitative (non-numeric data) through open-ended questions.

5. The underlying philosophical positions of the two approaches to research are not as distinct as the stereotypes suggest.

There are a number of contrasting features of quantitative and qualitative research as shown in Table 4.3. The difference between each one, according to Naoum (1998) may be somehow quantifiable but such measurements will not convey the importance and special impact of some over others.

Table 4.3 Strength and Weaknesses of Research Paradigms

| | Strengths | Weaknesses |
|---|---|---|
| Positivist paradigm | Provides wide coverage of the range of situations.<br><br>Approach can be fast and economical.<br><br>Where statistics are aggregated from large samples, they may be of considerable relevance to policy decisions. | Methods used tend to be rather inflexible and artificial.<br><br>Not very effective in understanding process or the significance that people attach to actions.<br><br>Not very helpful in generating theories.<br><br>Because the focus is on what is, or what has been recently, this makes it hard for policy-makers to infer what changes and actions should take place in the future. |
| Phenomenological paradigm | Data gathering methods seem more natural.<br><br>Offers the ability to understand people's meanings.<br><br>Offers the ability to adjust to new issues and ideas as they emerge.<br><br>Contributes to theory generation. | Data collection can be tedious and requires more resources.<br><br>Analysis and interpretation of data may be more difficult.<br><br>Policy-makers may give low credibility to results from qualitative approach. |

Source: Amaratunga *et al.* (2002, p.20)

Making a research strategy for any research is vital and important because "*the researcher is faced with a variety of options and alternatives and has to make strategic decisions about which to choose*" (Denscombe, 2005). Therefore, the researcher has to make a decision for each choice selected. Moreover, "the crucial thing for good research is that the choices are reasonable and that they make explicit as part of any research report" (Denscombe, 2005). Saunders *et al.* (2007) note that the main research strategies are experiment, survey, case study, grounded theory and action research. Yin (2003) pointed out that a research strategy should be chosen as a function of the research situation because each research study differs and there will be advantages and disadvantages to be gained by certain collection and analysis techniques. Although each strategy has its own defining characteristics, there are overlapping areas, which bring complexity to the process of strategy selection. Saunders *et al.* (2007) observe that the benefits of adopting a research strategy include:

- Allowing oneself sufficient time
- Using existing contacts and developing new ones
- Providing a clear account of purpose and type of access required
- Overcoming organisational concerns about the granting of access
- Using suitable language; facilitating ease of reply when requesting access
- Developing access on an incremental basis and establishing researcher credibility with intended participants.

The design of this research considered many issues such as the nature of the research and how to examine the importance of agricultural infrastructure in agricultural transformation in aspects such as agricultural infrastructure availability, agricultural infrastructure accessibility and agricultural infrastructure influence.

### 4.5 Research Methods

In selecting a method for the collection of data, certain research strategies tend to be associated with the use of certain research methods. The data collection strategies used in this research consisted of a questionnaire survey and semi-structured interviews. This research uses a mixed methods approach in order to achieve the research aims and objectives, and to answer the research questions through data triangulation. This research was initially exploratory as there was no previous research on this subject in Libya. Based on the research objectives which were stated in Section 1.4 of Chapter 1, data were collected based on concepts and theories on organic farming, as discussed in Chapter 2.

Selecting suitable research methods was largely driven by the research context and problems identified from the literature review (Allison *et al.*, 1996; Remenyi *et al.*, 1998). This research therefore uses both qualitative and quantitative approaches in order to gather detailed information about agricultural infrastructure and the importance of this for organic farming conversion.

## 4.6 Mixed Methods Approach

Mixed method research usually refers to the use of both qualitative and quantitative methods in one study. Amaratunga *et al.* (2002) note that there is a strong suggestion within the research community that both quantitative and qualitative methods are best thought of as complementary and should therefore be mixed in research. Mixed-methods research uses qualitative and quantitative techniques together to study a topic and the combination is a powerful one for gaining insights and results.

Whilst researchers acknowledge that there are epistemological challenges in using both qualitative and quantitative techniques in one research, Das (1983, p.301) notes that

"*...qualitative and quantitative methodologies are not antithetic or divergent; rather they focus on different dimensions of the same phenomenon. Sometimes, these dimensions may appear to be confluent: but even in these instances, where they apparently diverge, the underlying unity may become visible on deeper penetration...The situational contingencies and objectives of the researcher would seem to play a decisive role in the design execution of the study.*"

## 4.6 Reasons for selecting the above methods

The reason for adopting a mixed-method approach for this research was to gain a fuller understanding of the research problem. Again the use of mixed methods in this research was to allow the use of multiple data sources with similar foci so as to obtain diverse views about the research problem for the purpose of validation (Data Triangulation).

The quantitative method, a questionnaire survey, was considered an appropriate method because of the expected high number of respondents (farmers) who were involved in the research and also the spatial distribution of the farms in the three most important agricultural regions in the Libyan area.

Because testing people's opinions about certain aspects of the subject was a major part of the data-gathering for this research, interviews were considered as an appropriate approach instead of focus groups since it would have been difficult to bring the interviewees together in one location at the same time.

The selected methods will help answer the research questions and to achieve research objectives.

Questionnaires rely on written information supplied directly by people in response to questions asked (Denscombe, 1998). The kind of data collected from questionnaires is distinct and different from those obtained by interviews or observation, or from reviews of documents. The information from questionnaires tends to fall into two broad categories: 'facts', which do not require much in the way of subjective judgement or personal attitudes on the part of respondents. The other category is that of 'opinion' where the attitudes, views, beliefs and preferences of respondents are investigated. A questionnaire survey is appropriate when gathering information from large numbers of respondents, and is especially useful for surveys in many locations. In addition, this approach is suitable if the required information is relatively unambiguous. There are different types of questions that can be used in a questionnaire, and there are both numerous advantages and disadvantages to the use of questionnaires (Denscombe, 1998).

### 4.7 Advantages of Questionnaire Surveys

The use of a questionnaire was considered appropriate for this research due to the advantages listed below:

Questionnaires are economical: they can be used to collect a considerable amount of research data at relatively low cost in terms of materials, money and time.

Questionnaires are easier to use to reach greater numbers of respondents than personal interviews can do. A questionnaire allows the same questions to be posed to all respondents with no scope for variation and the data collected are very unlikely to be contaminated through variations in the wording of the questions or the manner in which the question is asked.

One of the most important advantages of questionnaires is that it encourages pre-coded answers and this allows for speedy collation and analysis of data.

## 4.8 Disadvantages of Questionnaire Surveys

Whilst the above advantages can be attributed to the use of questionnaires, they also have the following disadvantages:

Pre-coded questions can be frustrating for respondents and thus deter them from answering. The box-ticking routine might encourage people to respond but this routine might be experienced as negative and put people off cooperating with the research.

Pre-coded questions can bias the findings towards the researcher rather than the respondent's way of seeing things. There is always the danger that the options open to respondents when answering the questions will channel responses away from their own perception in order to fit the thinking established by the researcher.

Questionnaires offer little opportunity for the researcher to check the 'truthfulness' of the answers given by the respondents.

## 4.9 Advantages/Disadvantages of Interviews

One major advantage of the interview technique is its adaptability. A skilful interviewer can follow up ideas, probe responses and investigate motives and feelings, which the questionnaire cannot do. The way in which a response is made (for instance, the tone of voice, facial expression, or hesitation), can provide information that a written response would conceal. Questionnaire responses have to be taken at face value, but a response in an interview can be developed and clarified (Bell, 2006).

On the other hand, interviews are time-consuming. For example, in a100-hour project the researcher will be able to interview only a relatively small number of people. It is a highly subjective technique and therefore there is always the danger of bias. Analysing responses can present problems, and wording the questions is almost as demanding for interviews as it is for questionnaires. Even so, the interview can yield rich material and can often put flesh on the bones of questionnaire responses (Bell, 2006).

## 4.10 Site Selection

The following agricultural regions were chosen for sampling:

North East (Region 1), Algabal Al-kdar

North West (Region 2), Aljafara

The South (Region 3), Fazzan

These regions were chosen because they are considered to be the main agricultural regions in Libya. They also represent a wide range of geographical areas with different topography and a variety of agricultural products. Figure 2.1 presented earlier illustrated the location of agricultural regions. More details about these regions in terms of altitude, average rainfall, soil types, etc. are also presented in Chapter 2.

The selection of these sites was based on the variation of crops produced and sources of water used for agricultural activities in each region. Moreover, the type of soil was one of the most important factors for the selection site. This is further discussed in Chapter 2.

The importance of the three selected agricultural regions was to enable a detailed analysis to be made spatial variations of the role of agricultural infrastructure on transformation in place across the agricultural regions. The selection of the regions was based on information gathered from documents from the Libyan Ministry of Agriculture (MOA).

## 4.11 Sampling Process

Non-probability techniques are one way to select a sample for research. It provides a range of alternative methods to select samples based on subjective judgement (Saunders *et al.*, 2007). For this research, purposive sampling was chosen as an appropriate sampling approach. With purposive sampling, the sample is 'hand picked' for the research (Saunders *et al.*, 1997). The reasons are that it is not feasible to randomly select the respondents since there is no database on them; there is not sufficient information about the population to undertake probability sampling; and the researcher did not know who or how many people make up the population. Thus it was considered that it would be exceedingly difficult to contact a sample selected through conventional probability sampling techniques. Due to a lack of available information about the agricultural infrastructure in the selected sites, the researcher approached the study through non-probability sampling techniques. In addition, with the large numbers of farmers and farms in the selected area, it was impossible to undertake a comprehensive survey. The pilot survey showed that many farmers were not literate enough to understanding the questionnaires or were not knowledgeable in agriculture infrastructure issues.

### 4.12 Sample Selection and Size

To undertake this research, relevant respondents were selected to answer the research instrument (self-administered questionnaire) and to take part in interviews. The sample for this research was made up of farmers with not less than ten years' experience in agricultural activities and with farm sizes not less than 5 hectares. The determinations criteria for choosing the farmers and farms was achieved by asking the farmers directly how many years of experience they had in the agricultural sector and what size their farm was. This was also the procedure used by the researcher for the farmers who already knew and through some people who were involved in working in Agricultural societies in Libya. The researcher determined these criteria for this research due to the nature of the research, which was considered as very exploratory, as it is important for the respondents to have a good knowledge of the roles of agricultural infrastructure.

These criteria for sample selection were determined according to the researcher's experience in the agricultural sector. This selection was based on the researcher's 20 years' experience of working in agriculture. Therefore, this led him to determine that for farmers with 10 years' experience it could be an appropriate time for them of agricultural infrastructure. In addition, the researcher believed that farmers with 10 years' experience could answer the survey research questionnaire without difficulty. The reason for selecting farms not less than five hectares in size is that it is known from a preliminary assessment to be a common size for many Libyan farms. This size of farm would enable the generation of good information on different kinds of infrastructure and by selecting the 5-hectare size it would be reasonable to use machinery and equipment as well as to introduce methods and implement agricultural practices. The achievement of all this would depend on the availability of agricultural infrastructure. However, if farms of less than 5 hectares were chosen, it would not be possible to achieve good results on the role of agricultural infrastructure in agriculture activities.

Generally, the sample size was determined according to the specific purpose of this study. This is the first research in Libya about agricultural infrastructure and transformation to organic farming. The respondents were selected from the three most important agricultural regions in Libya, which account for 80 % of agricultural land in the country. The sample sizes selected for each region were important in order to ensure accuracy and reduce sampling errors. Neuman (1997) stated that one of the principles for determining sample sizes is that the smaller the population, the bigger the sampling ratio has to be for an accurate sample. On the other hand, a larger population permit smaller sampling ratios for equally good samples and accuracy. In addition, practical limitations (time and finance) also played a part in the researcher's decision to define the sample size. However, these sample sizes were manageable, yet large enough to represent each region in the whole sample size.

For this study, a set of questionnaires was delivered to selected farmers. As mentioned, the target sample was selected according to their experience (not less than ten years farming), and that they managed a farm which was not less than five hectares in size.

### 4.13 Quantitative Data Collection Using Questionnaires

This research used questionnaire surveys to generate information on the agricultural setting and farmers' experience in agriculture activities on farms in different agricultural regions in Libya. Overton and Diermen (2003) stated that quantitative techniques are an appropriate method of doing research in Third World Countries if precise objective and replicable answers were needed.

Before the main data collection, which took place in December 2008, a six-month pilot study was undertaken between May and October 2008 in the three agricultural regions.

Hoggart *et al.* (2002, p.181) state that "*in survey work, a first step in checking the credibility of an instrument is a pilot survey*". Therefore, the pilot study is important, to test how the instrument works before conducting the whole research. Therefore, to determine how well an instrument works is a significant procedure so as to ensure the validity of the research tools (Caunce, 1994). All data gathering for the survey questionnaire was piloted with a view to giving a chance to discover some content as well as structural problems that can be amended before embarking on a full-scale survey. Therefore, this was implemented to achieve the purpose of the pilot exercise, to resolve any problems with the instrument so that the researcher could ascertain all the difficulties that respondents faced in completing and understanding the questions of the research questionnaire. It also enabled the researcher to carry out a preliminary analysis to check the wording and format of questions to make sure that these would not present any difficulties when the data was analysed (Bell, 2006).

This study utilised a pilot sample of 60 farmers in the agricultural regions mentioned. A number of problems were encountered during the pilot study. Since the questionnaires were first developed in English and then translated into Arabic some questions lost their true meaning in translation, thus making it difficult for farmers to answer. Secondly, the farmers took a long time to complete the questionnaire. Some farmers attributed this to the length of the questionnaire. Thirdly, some farmers did not answer all the questions, due to a lack of information that they had in specific areas such as organic farming and biological control. Fourthly, it was difficult to conduct the pilot study within the allocated time because the sample had to be made up of farmers with 10 years' experience in agricultural activities, and as it turned out, such a sample was not easy to identify.

Therefore, after the pilot study, the researcher went through each of the questions together with the farmers to make sure they had understood what each question was looking for. This meant that the researcher had to change the format of some questions and make them clearer; for example, a question regarding the availability and effectiveness of flood irrigation was not understood properly, so this was changed after the pilot study to conventional irrigation instead flood irrigation (see Appendix 2, Section 2). In addition, the length of the questionnaire was reduced by minimizing the format of some questions and putting it onto one page instead of two. For example, the question of agricultural infrastructure availability consisted of one page on agricultural infrastructure availability in the region and a second page on agricultural infrastructure availability in the farm. Due to farmers' complaint about this issue, the researcher amended the format of the question by joining the two questions and putting them onto one page instead two.

Furthermore, the farmers found it difficult to answer some questions without explanations, such as questions about how important were the current infrastructures in the use of agricultural inputs, where there were three options for answering, which were: very important, important, not important. Farmers were confused about how to answer the question because it is difficult to measure the scale of the answers option without having an explanation, so the researcher added some explanations for each answer, as shown in the following example:

Chemical fertilizer with Transportation:

Very important: Without transportation you cannot reach the market to buy fertilizer or use it.

Important: Transportation is necessary to encourage farmers to reach the market to buy fertilizer.

Not important: You can reach the market to buy fertilizer without needing transportation.

The primary data were collected over seven months (October 2008 till April 2009). With the practical limitations of research techniques, a researcher has to choose an appropriate technique for their research. Decisions on what techniques would be appropriate for the research are made after matching the different techniques with the research questions (Neuman, 1997). In this type of study, the researcher employs informed judgment to understand the weakness and strength of each technique that could be used for the research. The selection of the method or the techniques used for the research depends on what kind of information is needed, from whom and under which circumstances. This decision is made at the beginning of the research project, but it may be feasible to add supplementary methods during the project. While a questionnaire survey was used in this research as the main data collection technique, interviews were also conducted with key agricultural institutions. This was to enable the researcher to access their perceptions, meanings, definition of situations and constructions of reality. The survey was used to translate the research problem into questionnaires which asked respondents relevant questions, so as to create data which was analysed to address the research problem (Nachmias and Nachmias, 1997; Neuman, 1997).

The purpose of the data collection in this research is to confirm the existence of agricultural infrastructure availability and accessibility and their roles in using the inputs, beside its roles in agricultural development in transformation to organic farming system.

The characteristics (farm and farmer) of the respondents, their experiences, opinion and behaviours were the bases of the questions in this research are referred to Appendix 2. Such requirements focus the research on the perceptions of all the actors concerned with the agricultural activities and the outcome of the agricultural infrastructure availability and accessibility. The researcher determined many key themes of the research topic. The themes were selected to address and answer the research questions and to achieve the research aims and objectives. These themes helped the researcher to design and develop the questions in the questionnaire as well as interviews based on research questions and aims and objectives. The themes were then organized into different categories such as agricultural infrastructure availability, accessibility and quality.

The techniques used to gather data for this research were considered to be the most appropriate way of answering the research questions. These relate to agricultural practices and to the inputs and extent of infrastructure which enables farmers to address key issues. These include caring and long term soil fertility, use of chemical and manure fertilizer, following soil rotation and use of biological combat, and extending areas of agri-land holding.

It also focuses on how the current agricultural infrastructure can produce greater varieties of crops, and on farmers' decisions to undertake all necessary agricultural practices, introduce new technology, introduce new agricultural methods and generate higher profits.

The use of multiple source of evidence in this study allowed the researcher to address a broader range of research issues. The most important advantage of this method, however, is the process of triangulation. Patton (1990) defines triangulation as "the combination of methodologies in the study of the same phenomena or programs" and stresses that an important way to strengthen a study design is through triangulation. In this study, the data sources were triangulated by distributing the questionnaire in three agricultural regions, and farmers who have 10 years or more of experience in agricultural activities, were targeted to answer the questionnaire. The data which were collected from different sources were a very important part of the study, and so the Libyan data were collected from Ministry of Agriculture reports, FAO reports and some Libyan academic agricultural books. The other data were collected from scientific papers and academic books.

The interview schedules were all administered by the researcher.

The total numbers of questionnaires distributed in the pilot study are shown in Table 4.4 below.

**Table 4.4 Total Number of Questionnaires Distributed in Pilot Study**

| Agricultural Régions | Number of Questionnaires |
|---|---|
| Algabal Al-kdar | 200 |
| Aljafara | 200 |
| Fazzan | 200 |

### 4.14 Main Questionnaire Distribution

The researcher distributed 600 questionnaires to farmers in the three selected agricultural regions. The questionnaires were equally distributed to 200 farmers (representing 200 farms for each region). The questionnaire was distributed equally due to many reasons such as far distance, which can reach to 1000 km between one region and another. The distribution was affected by budget availability (funded by the researcher). The researcher spent a great deal of money on travelling between agricultural regions, on accommodation, and on transport. Furthermore, there were difficulties in contacting farmers at a specific time and difficulties in recognizing the criteria for the farms and that for the farmers. Difficulties in recognizing the criteria for both the farms and farmers was due to records not being available for the sample criteria in the regions and also due to the expansion of agricultural land without permission from the authority for agriculture. This has led to this expansion not being recognized officially in the authority records. Due to these constraints the researcher decided to distribute the questionnaire equally in each region, and this also makes good sense in terms of the research design.

The questionnaire survey was targeted across the three main agricultural regions in Libya. It was sent out through the Libyan agricultural societies since most of the farmers are members of these societies and also distributed direct to farmers who were already known by the researcher and some friends and relatives. The questionnaire was designed to collect the necessary information about the availability and management of agricultural infrastructure both 'on farms' and 'within the region'. Additionally, the questionnaires also gathered information about the role of the current available infrastructure in affecting key aspects of agricultural practice, which might influence any desired transformation to organic farming.

Table 4.5 shows that the total number of respondents who returned the questionnaires was 277 farmers representing 277 farms. A response rate of 46% was thus achieved. Response rate is defined by Denscombe (1998) as the proportion of the total number of questionnaires distributed which are completed and returned. The breakdown of the respondents into regions was 99 of the respondents (36 percent) from the Algabal Al-kdar region, 83 of the respondents (30 percent) farmers from the Aljafara region, and 95 of the respondents from the Fazzan region representing 34 percent of the total respondents.

Table 4.5 Total of Respondents According to Agricultural Regions

| Agricultural Region | Number of Farmers Respondents | Valid Percent |
|---|---|---|
| Algabal Al-kdar | 99 | 35.7% |
| Aljafara | 83 | 30.0% |
| Fazzan | 95 | 34.3% |
| Total | 277 | 100% |

## 4.15 Qualitative Data Collection by Means of Semi-Structured Interview

In addition to the use of the quantitative approach to collect data, qualitative methods were also used to gather more in-depth data. Qualitative methods refer to research procedures which produce descriptive data: people's own written or spoken words, and records of observable behaviour. It allows us to know people personally and to see them as they develop their own definitions of the world (Bogdan and Taylor, 1995).

Interviews are an attractive proposition for project researchers. At first inspection, they do not seem to require much support and they draw on a skill that researches already have – the ability to conduct a conversation (Denscombe, 2005). Whilst interviews can be used for the collection of straightforward information, their potential as a data collection method is better exploited when they are applied to the exploration of more complex and subtle phenomena (Denscombe, 2005). There are several types of research interviews, such as structured, semi-structured, and unstructured interviews. However, this research used semi-structured interviews to collect data.

With semi-structured interviews, the interviewer has a clear list of issues to be addressed and questions to be answered. However, the interviewer is prepared to be flexible in terms of the order in which topics are considered and perhaps more significantly, to let the interviewee develop ideas and speak more widely on the issue raised by the researcher. The answers are open-ended, and there is more emphasis on the interviewee elaborating points of interest (Denscombe, 2005).

The aim of the thesis is to explore the role of agricultural infrastructure on agricultural transformation in Libya and to find out to what extent agricultural infrastructure can play a part in the transformation to organic farming.

This required the qualitative technique of formal interviews with experts in the agricultural sector and utilised a series of questions which looked at the role of agricultural infrastructure in agriculture transformation to the organic farming approach in Libya. Using interviews as a qualitative method is common. As Kitchin and Tata (2000) stated, interviewing is probably the most commonly used qualitative technique, as it allows the researcher to produce a rich and varied data set in a less formal setting.

The qualitative approach of semi-structured interviews was required for gaining a more in-depth insight into the spatial variation of agricultural infrastructure and its role in agricultural transformation in Libya.

A series of key interviews was undertaken during the pilot study as part of the scoping exercise for the research. This helped to formulate both the questions for questionnaires and further interviews and the detailed methods to be applied. As part of the mixed methods approach adopted for this research, a series of interviews were conducted with key people in Libyan institutions that have a bearing on the research subject. Semi-structured interviews were undertaken to gather detailed information about the types and importance of the current infrastructure in Libyan agricultural sector. The roles of infrastructure in developing agricultural systems were investigated. These interviews were designed to gather in-depth information about whether the current available infrastructure is sufficient or appropriate for introducing new and innovative approaches to agricultural systems such as 'organic production'.

The questionnaire was the first method used to conduct the farmers, and was then followed by interviews to conduct agricultural experts. This was because the researcher considered that the questionnaire is the main method for this research because the research is focused on farmers' challenges with agricultural infrastructure and how the availability and accessibility of the existing infrastructure could lead to or hinder the transformation to organic farming. Therefore, farmers' experience is more important because their experience of the challenges with agricultural infrastructure could lead to facilitating or hindering the transformation to organic.

The interviews were conducted with representatives of the following key Libyan institutions:

1. People's Committee for Agriculture and Animal Production (Ministry of Agriculture )
2. General Planning Council
3. General Environment Authority
4. Agricultural Bank
5. General Water Authority
6. Arial Agricultural Project
7. Fazzan Settlement Area
8. Fazzan Agricultural Area
9. National Committee to Combat Desertification
10. People's Committee for Monitoring and Inspection

The interviews were conducted with 12 experts involved in agricultural activities in Libya. Table 4.6 below presents full details of the interviewees. Each of the semi-structured interviews was undertaken between October 2008 and April 2009 and lasted for at least an hour and was digitally recorded for transcribing. (Appendix 3 gives an example of an interview transcript). The 12 experts interviewed were involved in agricultural activities and are decision-makers in their positions. The sampling of the interviewees was based on a non-random sampling method, choosing people who are knowledgeable in the research area to fulfil the sampling requirement (Kitchin and Tate, 2000).

**Table 4.6 List of Organisation Interviewed**

| | Organization | Position of Interviewee |
|---|---|---|
| 1 | People's Committee for Agriculture and Animal Production | Senior |
| 2 | General Environment Authority | Engineer |
| 3 | National Committee to Combat Desertification | Senior |
| 4 | Fazzan Agricultural Area | Retired Expert |
| 5 | Fazzan Settlement Area | Retired Expert |
| 6 | General Planning Council | Expert |
| 7 | Arial Agricultural Project | Senior |
| 8 | Agricultural Bank | Senior |
| 9 | Peoples' Committee for Monitoring and Inspection | Manager |
| 10 | General Water Authority | Engineer |

Additionally, the primary data gained through the interviews with the specialists were supplemented by secondary data from research papers, official reports and other statistical publications. Thus the secondary data collected supplemented the primary data (quantitative and qualitative) for the research.

In addition to the interviews, in-depth discussions were held with many key organizations which were relevant to the research, such as the People's Committee for Agriculture and Animal Production, the People's Committee for Monitoring and Inspection, the National Committee to Combat Desertification, the Agricultural Bank, the Fazzan Settlement Area, the Fazzan Agricultural Area, the General Planning Council, the Arial Agricultural Project, the General Water Authority and the General Environment Authority. Visiting the Algabal Al-kdar, Sahal Aljafara and Fazzan regions was important, so as to have a clear idea of the site selected for the research.

## 4.16 Validity and Reliability

Validity is the term used to describe the extent to which the chosen research instrument measures what it is supposed to measure (Punch, 1998). In other words, the assessment of validity addresses how effective the research approach has been. In order to ensure the validity of this research the variables in both the quantitative survey instrument and the interviews were formulated to help answer the main research questions.

In order to assess the validity of the hypothesis of this research, it was necessary to develop measures of the constituent concepts. These concepts were discussed in Chapters 2 and 3. These concepts were then operationalised into variables which were used in the development of the survey instrument as well as the interview schedule.

Reliability basically means consistency and accuracy achieved in a research (Punch, 1998). The consistency of this research will be measured by ensuring that all propositions, assumptions and conclusions are consistent with each other. The research process reviewed findings to assess the degree to which they indicate the same direction and the same objectives. Consistency was also achieved through stability of measurement with consideration as to time. It is assumed that consistent results would be achieved if the same instrument was given to the same respondent under the same circumstances at a different time.

### 4.17 Introduction to the Process of Data Analysis

All the data gathered was analysed and interpreted by using appropriate analytical techniques. The quantitative data was analysed by using the Statistical Package for Social Sciences (SPSS). Descriptive techniques were used; for instance, a frequency distribution was used to describe a single population, to examine the distribution of each of the variables and it considered a tabulation of the frequencies of each value. This was important in order to understand the impact on each variable on the research issues. Furthermore, cross-tabulation techniques were used to look at the interrelationship between two variables and to understand the strength of the relationship between variables. The qualitative data were analysed and interpreted manually due to the small sample size of the interviewees. The interview was analysed according to the research themes which aimed to answer the research questions and to achieve the research aims and objectives.

Quantitative data analysis may be used at a number of levels. Many small-scale research studies, which use questionnaires as a form of data collection, will not need to go beyond the use of descriptive statistics and the exploration of the interrelationships between pairs of variables (Blaxter, 1996). Data analysis may also go beyond this level of descriptive analysis and make use of inferential statistics or multivariate methods of analysis to explore the interrelationships between variables. The uses of data triangulation, combining both quantitative and qualitative data, were employed in the discussion chapter to achieve a greater understanding of the research problem.

### 4.18 Research limitations

The common research constraints of time, access and finance limited the scope and scale of this study. In order to manage these constraints, the fieldwork was conducted with farmers in three agricultural regions. Availability of secondary data was one of the difficulties encountered in this research, due the lack of information in the research topic, especially for development infrastructure, and the history of agriculture in Libya, practically from the medieval era.

Developing a research strategy for collecting primary data in the regions of Algabal Al-Akdar, Aljafara and Fazzan was difficult and took a long time; more than expected. It was hard work with correspondence, meetings and discussions with key players on this research. It was difficult focusing on the area of the research by asking specific questions to examine the importance of agricultural infrastructure and its important role in agricultural transformation to organic farming as a new approach, since the concept is new in Libya.

# CHAPTER FIVE

## QUANTATIVE DATA ANALYSIS

### 5.0 Introduction

This Chapter discusses and analyses the results of the questionnaires survey that were carried out in Fazan, Aljafara and Algabal Al-kdar agricultural regions in Libya. The quantitative data was collected from 277 farmers who have been involved in agricultural activities for 10 years or more and who own farms not less than 5 hectares in size.

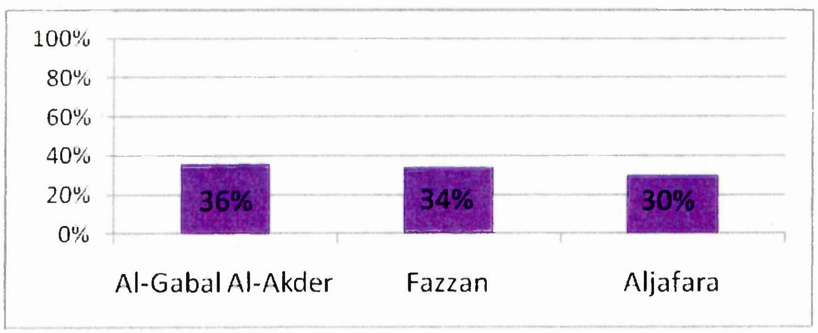
The quantitative data were analysed using Statistical Package for Social Sciences (SPSS v.18) software. The descriptive analysis was conducted using the demographic characteristics of the respondents, of their farms and infrastructure availability and accessibility and its role in agricultural operations and practices. These variables are presented in tables and figures where appropriate. Further bivariate analyses were conducted to evaluate the relationships between the variables.

### 5.1 Demographic Characteristics of Farmers

Farmers' decisions to convert to organic farming may be influenced by general information that they have acquired. Therefore, the information acquisition process might induce a shift in the probability of adopting the new technology. Farmers' information gathering is expected to enhance resource allocation skills and to increase the efficiency of adoption decisions (Genius *et al.*, 2006). Therefore, farmers with a high level of resource allocation skills will make more accurate predictions of future yields and profitability, and thus will make more efficient adoption decisions (Just and Zilberman, 1983). Several researchers indicates that the role of the human capital theory and innovative characteristics ability, which is dependent on education level, experience and information accumulation, were associated with the resource allocation skills of farm operators (Schultz, 1972; Huffman, 1977; Rahm and Huffman, 1984). Therefore, analyzing the socio-economic status of farmers and farms researched in this study is important in order to understand the development of organic farming in other countries when considering the transformation to organic farming in Libya. Studies such as those by Fairweather, (1999) and Midmore *et al.* (2001), attempt to characterise and quantify the number of conventional farmers considering the conversion to organic farming. Furthermore, the role of the various driving forces at the farm level is crucial in order to understand and promote the adoption of organic farming methods. This is because transformation is a complex innovation that requires a strategic or systematic change on the part of the farmer (Padel, 2001).

The section data analysed the situation of the status of conventional farmers and farms in three agricultural regions. Analyses of respondents to the questionnaires shows that they are almost equally distributed among the three agricultural regions surveyed: Algabal Al-kdar (36%), Fazzan (34%) and Aljafara (30%) (See Figure 5.1). This section presents the demographic information about the respondents in terms of gender, age, level of education, and experience. Analysis of these variables is necessary since they influence agricultural development.

**Figure 5.1 Agricultural Regions**




Source: Survey Data, 2008; N=277

### 5.1.1 Gender

The analysis of the questionnaire shows that all the farmers are male (see Table 5.1). This reflects the dominance of men in agricultural activities in Libya. The implications of this dominance are discussed in detail in Chapter 7.

**Table 5.1 Gender Distribution**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | MALE | 277 | 100.0 | 100.0 | 100.0 |

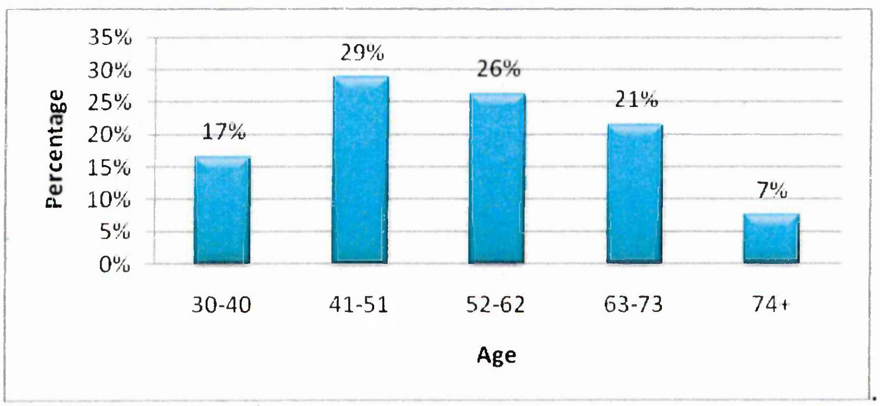
Source: Survey Data, 2008; N=277

### 5.1.2 Age

The age of farmers determines to what extent they can operate the farm. Thus, older farmers might have physical difficulties which could prevent them converting to organic farming which is considered a labour intensive system (Fasterding and Rixen, 2006; Trauger *et al.*, 2008). Furthermore, age appears to be associated with farmers' attitude to conversion to organic farming. In Denmark it was found that a positive attitude towards conversion was highest among farmers less than 40 years old (Tress, 2003).

In the present research, the age of the sample of farmers was categorised into five groups (see Figure 5.2).

**Figure 5.2 Age Distribution**




Source: Survey Data, 2008; N=277

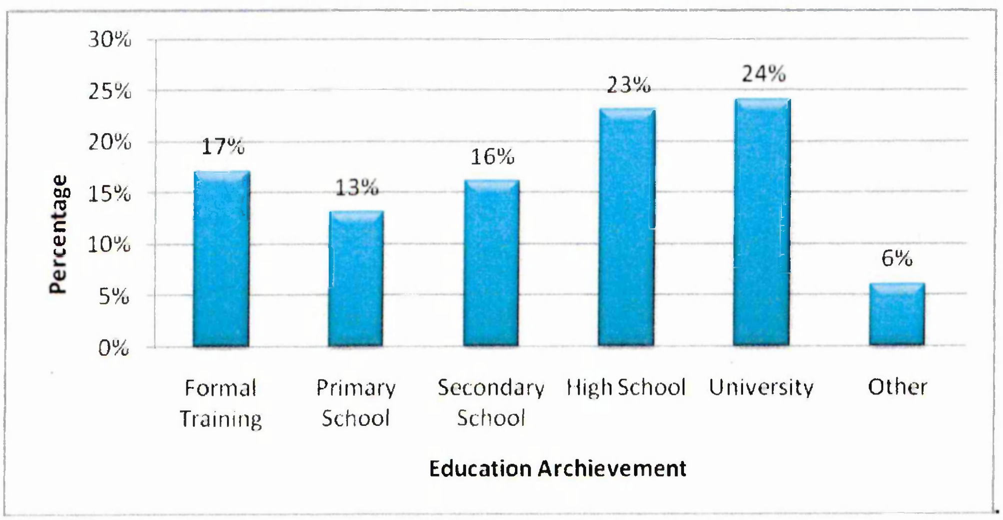
The data highlight that farmers aged 30-51 years formed 46% of the respondents and farmers aged 52 and above were 54%. The data also show that the mean age of farmers is 53.8 years with a standard deviation of 13.5 years. A detailed evaluation of the data shows that the largest percentage (29%) of farmers is in the age band of 41-51 years. Farmers aged 52-62 and 63-73 years made up 26% and 21% respectively. Tress (2003), in a study in the county of Ribe in Denmark found that the percentage of farmers with a positive attitude towards conversion to organic farming was highest among farmers less than 40 years old. Furthermore, Lockeretz (1995) found that in Massachusetts, USA, organic farmers tended to be younger than non-organic farmers. In addition, the UK's Soil Association (2006) findings supported Lockeretz's research. Thus in the case of Libya, 46% of farmers could be considered as sufficiently young to be targeted by stakeholders for conversion to organic farming.

Further discussion of the implications of the age of farmers on the development of new agricultural practices such as organic farming will be discussed in Chapter 7.

### 5.1.3 Level of Education

The level of education of farmers determines their ability to interpret information. According to Mather and Adelzadeh (1998), people with higher educational levels are more able to interpret information than those who have less education or no education all. Thus, education levels can affect the use of agricultural information and the implementation of agricultural practices. The level of education of the respondents was categorised into six different groups (see Figure 5.3) and a descriptive analysis was performed on the data.

**Figure 5.3 Distribution of Level of Education**




Source: Survey Data, 2008; N=277

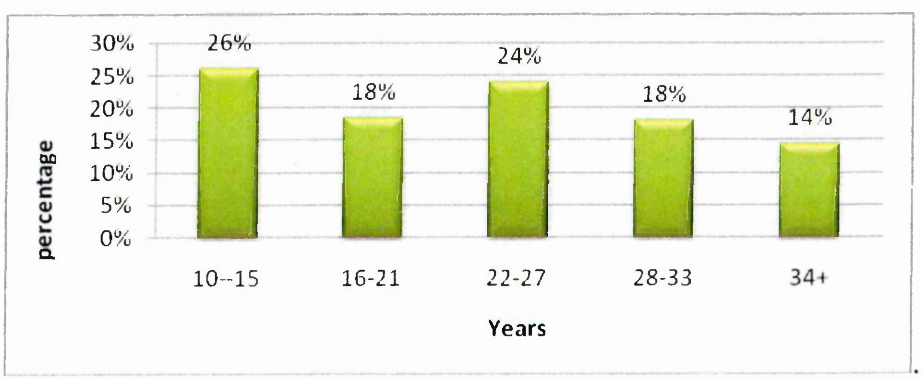
The date highlights that almost 50% of farmers have a satisfactory level of education (termed as formal training, high school and university). Detailed analysis shows that 24% of farmers have a university qualification, and 23% have high school qualifications. Furthermore, 17% have formal training which directly relates to farming practices, while only 6% have other types of qualifications.

Research by Anim (1999: 656), finds that more educated farmers tend to adopt organic farming methods more quickly than less educated ones. Furthermore, several studies from other countries have reported organic farmers to be better educated than their conventional counterparts (Padel, 2001). Thus, the results which show that a level of farmer's education in Libya is high should encourage policy makers to develop organic farming in Libya by targeting the more highly educated farmers. The finding of this study which indicted that 24 % of farmers in Libya has university education which it might good for stakeholder to target this category of age to be a pioneer in adopting organic farming in Libya.

### 5.1.4 Experience

Experience is crucial to managing farms as a high level of experience is necessary in order to take the correct action at the correct time. The years of experience of sampled farmers was categorised into five groups (see Figure 5.4) and a descriptive analysis conducted on the data. The data show that 44% of farmers have 10-21 years of experience, with 26% having 10-15 years experience and 18% have 16-21 years of experience. Only 14% have more than 34 years of experience. Further analysis of the data shows that the mean period of experience is 22.8 years.

**Figure 5.4 Distribution of Experience**




Source: Survey Data, 2008; N=277

Finding from this research are supported positively in research conducted in 2008 in Norway, which found that the average of organic farmers' experience in farming was nearly 22 years, which compares with the average for non-organic farmers of 25 years (Matthias *et al.*, 2008). Another study, carried out in Nigeria, shows that 56.7% of the organic farmers had 6 to 10 years farming experience (Adesope *et al.*, 2008).

### 5.1.5 Summary of Respondents' Demographics

- **Gender:** Agricultural activities are totally dominated by men.
- **Age:** The mean age of farmers is 53.8 years. More than half of farmers (55%) are aged 41-62 years.
- **Education:** Almost one quarter has a university education whilst 23% have a high school education.
- **Experience:** Farmers have a mean experience period of 22.8 years.

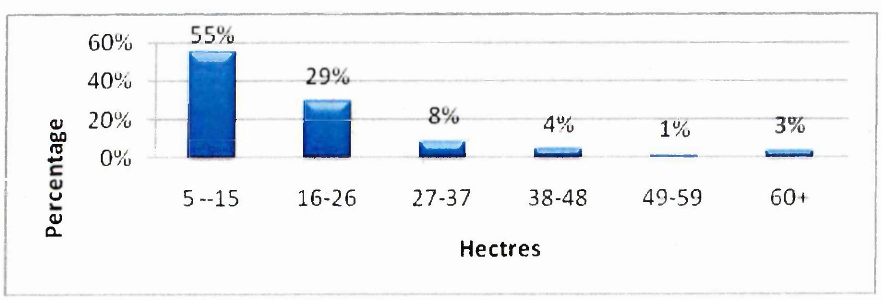
## 5.2 General Characteristics of Farms

The section analysis the characteristics of the surveyed farms including size, type, ownership, responsibility for decision making, number of farm managers and annual turnover

### 5.2.1 Farm Size

Farm size as based on the area of agricultural operation is an important factor used in classifying farms by socio-economic criteria. Figure 5.5 shows that majority, 145 (55%) out of 277 of farms surveyed are between 5 and 15 hectares, 29% are between 16 and 26 hectares and 8% are between 27 and 37 hectares. The mean farm size is 18.3 hectares with a standard deviation of 12.7 hectares.

**Figure 5.5 Distribution of Size of Farm**




Source: Survey Data, 2008; N=277

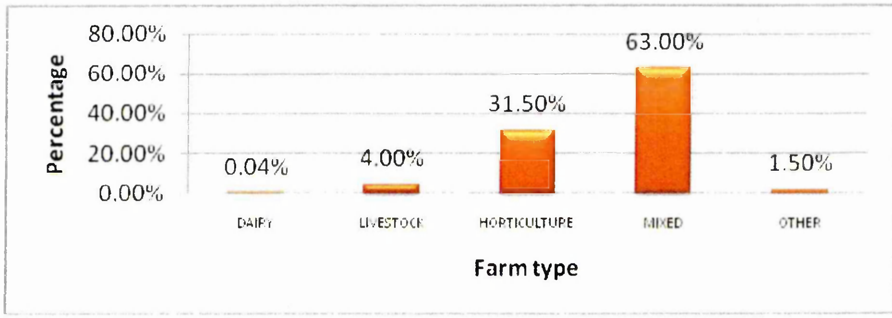
According to the results found in this study, more than 50% of farms in Libya are considered as small-sized (5-15 ha). The potential for conversion to organic farming of small farms is highlighted in the literature. In many countries organic farms tend to be smaller than non-organic farms (Harris *et al.*, 1980), including the United States, (Lockeretz & Anderson, 1990), Denmark (Dubgaard & Soerensen, 1988) and Canada (Henning *et al.*, 1991). There is a further discussion of farm size in Chapter 7.

### 5.2.2. Farm Type

In Libya there are two main approaches adopted by farmers in their farming system. The first is defined as conventional and has developed since the 1970s; in other countries, this type is known as integrated. The second system is organic but there are no official data because it is in its embryonic stages. Furthermore, organic commodities are not certified although they are mostly produced in the desert area without the use of chemicals. However, conventional farming, which represents the majority of agricultural land, uses modern technology and chemical inputs such as pesticides and artificial fertilizers. The study classified farms in Libya using the traditional methods: dairy farms, which comprise livestock for producing milk and cheese; livestock farms, which contain different kinds of animals such as sheep, goats, cattle, camels, horses and donkeys; horticulture farms, which grow different types of crops such as dates, oranges, grapes, vegetables, flowers, peaches, pears, figs, olives, wheat, barley and animal feed; mixed farms, which contain elements from each of the above-mentioned; and other farms, which include bees, poultry, seeds and seedlings, and flowers.

The analysis found that the majority of farms (63%) were of the mixed variety, 31.5% were horticulture, 4% were livestock, 1.5% were in poultry or bee production and only a few farms (0.04%) were classified as dairy (see Figure 5.6).

**Figure 5.6 Distributions by Farm Type**



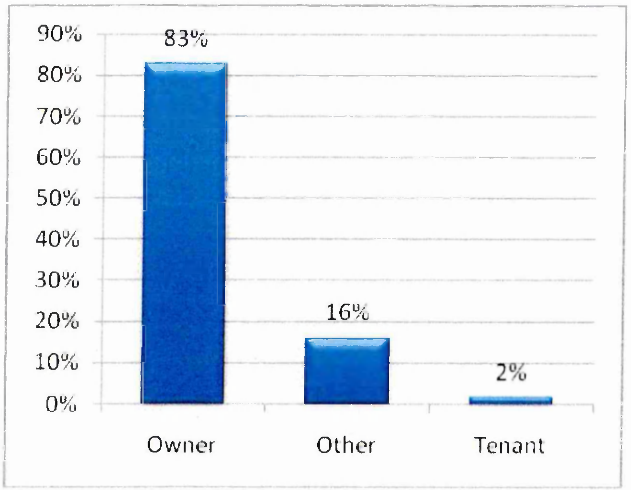

Source: Survey Data, 2008; N=277

This data is encouraging because the literature highlights that farmers who own horticultural farms are willing to convert part of their land to organic farming in order to diversify their risks. Furthermore, by converting only part of the farm they were mitigating the risk of converting all the land to organic farming. Thus, Niemeyer and Lombard (2003) found that in South Africa most converted farms were horticultural holdings and smaller than the average commercial farms. Therefore, this research suggests that decision makers should focus their efforts to convert to organic farming on horticultural farms.

### 5.2.3. Farm Ownership

The type of farm ownership in a country is influenced by social, political and economic issues. The means of production also reflect the extent to which a farmer is able to use his or her real estate as a farm. Furthermore, the availability of agricultural related assets influences the production and marketing of agricultural commodities. Thus, farmers who own their farms have more influence on what to produce and where to market their produce than those who not own their farms. This also indicates that farmers who own their farms have more options when making decisions related to agricultural activities than their counterparts who do not own their farm. In this research, ownership concerns were reviewed in the literature chapter. Figure 5.7 shows the distribution by farm ownership.

**Figure 5.7 Distributions by Farm Ownership**




Source: Survey Data, 2008; N=277

According to the data, 83% of the farms are managed by their owners, 16% are managed by tenants and 2% belong to the Ministry of Agriculture or local authorities and are managed by beneficiaries who do not pay any rent (see Figure 5.7). The result is important for policy-makers as it should be easier to motivate farmers to convert to organic farming, if they own the farm themselves. This finding is also supported by the literature: Stroebel (2004) argues that the availability of agricultural related assets influences production and marketing decisions among smallholder farmers. Furthermore, the UK's Soil Association (Crucefix, 1998) indicated that if farmers do not have title to their land, many are reluctant to plant permanent crops. Getting title for reservation land is a long and complicated process. However, the findings of this research about the owner condition in Libya do not agree with Kheder (2001) who argues that ownership is one of the main practical obstacles to conversion in Mediterranean countries. The findings also clarify that farmers in Libya do not have problems such as farmers being reluctant to plant permanent crops due to not having title to their land. The finding of this study is considered as motivating farmers to make a decision easily to convert to organic in Libya.

### 5.2.4. Responsibility for Decision-Making

Responsibility for decision-making is an important factor in the management of the farm. The farmer's ability to make decisions by him/herself is related to his or her ownership status. This ownership status is considered as a relationship between people and the land and this relationship is always associated with social, political and economic problems (Yalcin, 2011). Therefore, it is farmers who own their farm who are responsible for making any decision, rather than farmers who do not own their farms. This means that farmers who own their land are able to use it more than those who do not own theirs. The researcher argues that a farmer's behaviour is always motivated by choice which in turn is based on the responsibility of decision-making.

**Table 5.2 Responsibility for Decision-Making**

| | | Frequency | Valid Percent |
|---|---|---|---|
| Valid | YES | 261 | 96.0 |
| | NO | 11 | 4.0 |
| | Total | 272 | 100.0 |
| Missing | -99.00 | 5 | |
| Total | | 277 | |

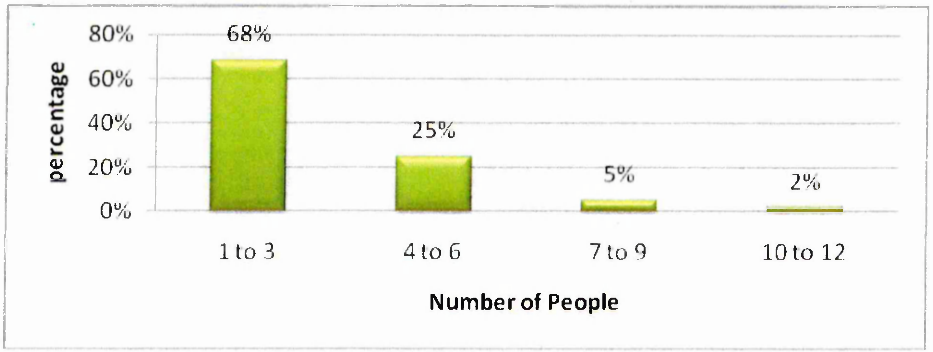
Source: Survey Data, 2008; N=277

The findings highlighted in Table 5.2 show a clear and positive picture of responsibility for decision-making in Libya. Ninety-six percent of farmers have responsibility for decision-making on their farms, while the remaining 4% are made by family members. This is supported by the finding of Yalcin (2011), who showed that farmers who own their land are able to use the real estate more than those who do not own property. This suggests that farmers in Libya who appear to have responsibility for making decisions by themselves amount to around 96% of the respondents of this study. Therefore, this finding might indicate that from this perspective, in terms of decision-making in relation to the conversion to organic farming, the process in Libya could be relatively easy.

### 5.2.5. Number of Farm Managers

Labour is an important element in the production process. The amount of labour in each farm is affected by factors such as farm size, farm type, farm system, to what extent farmers are committed to their agricultural practices and the use of technology. The number of farm managers was categorised into four groups. The results highlight that 93% of farms are managed by 1-6 people. In more depth, 68% of farms are managed by 1-3 people whilst 25% of farms are managed by 4-6 people. Farms managed by 7-12 people form only 7% of the respondents (see Figure 5.8). The data show that the mean number of people who manage farms is three.

**Figure 5.8 Distribution of Number of Farm Managers**




Source: Survey Data, 2008; N=277

The number of mangers will necessarily increase with the conversion to organic farming as it is a more labour-intensive method of farming. This result will increase labour opportunities in agriculture in Libya. Research highlights the importance of labour to the production process, and that it can be an impediment to the adoption of organic agriculture. Compared to large-scale mechanized agricultural systems, organic farming is more labour intensive. Many techniques used in organic farming require significant labour (such as strip farming, non-chemical weeding, and composting). In the developed world, labour scarcity and costs may deter farmers from adopting organic systems (Ortiz & Hue, 2009). From the researcher's experience, labour costs in Libya are significantly less than other countries such as Europe countries. This would give organic farmers in Libya competitive advantages over the developed countries' organic farmers.

### 5.2.6 Annual Turnover

Annual turnover, which is crucial for farmers, is affected by many factors such type of production, farm size, a farmer's commitment, effective agricultural practices such as biological and pest control, fertilization and tillage. Moreover, factors such climate, farmer's experience, and the availability and usage of agricultural inputs such as fertilizers, improved seeds and pesticides as well as quality of natural resources such as soil and water are also important factors.

Sources in Libya do not publish data relating to off-farm income and total household income. This is partly due to the lack of research and also the lack of stakeholder interest in this issue. The researcher suggests two further reasons: first, farmers are reluctant to provide data about income in order to avoid taxation problems. For this reason, the researcher warns against the accuracy of data in this section. In this study the category of annual turnover of sampled was categorised into ten groups (see Table 5.3). 78 % of the respondents have an annual farm turnover of between LD 1000 and LD 11999. In more depth, 52% earned between LD1,000 and LD5,999, 26% earned between LD6,000 and LD11,999 and 6% earned between LD12,000 and LD17,999. Overall, 16% earned above LD18000.

**Table 5.3 Distribution of Annual Turnover**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | 1000-5,999 | 140 | 50.5 | 52.4 | 52.4 |
| | 6000-11,999 | 68 | 24.5 | 25.5 | 77.9 |
| | 12000-17,999 | 16 | 5.8 | 6.0 | 83.9 |
| | 18000-23,999 | 13 | 4.7 | 4.9 | 88.8 |
| | 24000-29,999 | 13 | 4.7 | 4.9 | 93.6 |
| | 30000-35,999 | 11 | 4.0 | 4.1 | 97.8 |
| | 36000-41,999 | 3 | 1.1 | 1.1 | 98.9 |
| | 42000-47,999 | 1 | 0.4 | 0.4 | 99.3 |
| | 48000-53,999 | 1 | 0.4 | 0.4 | 99.6 |
| | 54000+ | 1 | 0.4 | 0.4 | 100.0 |
| | Total | 267 | 96.4 | 100.0 | |
| Missing | -99.00 | 10 | 3.6 | | |
| Total | | 277 | 100.0 | | |

Source: Survey Data, 2008; N=277

However, based on his experience in the agriculture sector, the researcher argues that results of the annual farm turnover are weak. This result could support farmers in converting to organic farming, as it attracts higher levels of income than non-organic farming does. Yet farmers are concerned about the risks of conversion, especially in relation to income.

### 5.2.7 Summary of Farm Characteristics

- **Size**: The mean size of farms is 18.3 hectares. More than 55% of farms in Libya are 5-15 hectares.
- **Type:** Most farms (63%) are mixed and 23% are horticultural.
- **Ownership:** Most farms (83%) are managed by their owners.
- **Responsibility for decision making:** Most farmers (96%) are responsible for decision making on their farms.
- **Number of managers:** The mean number of people who manage farms is 3. More than half of Libyan farms (68%) are managed by 1-3 people.
- **Annual Turnover:** The mean annual turnover of farms was LD9,414 with a standard deviation of LD3,610.

## 5.3 Correlation Analysis

This section analyses the relationship between two variables relating to the farmers and their farms by using correlation techniques such as cross-tabulation. Correlation techniques are useful as they provide greater insight into the relationship between variables than do frequencies statistics. The variables used for the correlation analysis are age, education experience, farm size, type, ownership, decision-making, and number of managers. The statistically significant relationships are shown in Table 5.4 and presented in the following sections.

**Table 5.4 Summary of Chi Square and Cramer's V**

| | Variables | Pearson Chi Square | Cramer's V |
|---|---|---|---|
| 1 | Age & Level of Education | P <0.000 | 0.292 |
| 2 | Age & Agricultural Region | P <0.001 | 0.236 |
| 3 | Level of Education & Experience | P <0.000 | 0.265 |
| 4 | Farm Type & Ownership Structure | P<0.000 | 0.237 |
| 5 | Farm Type & Responsibility for Decision-Making | P <0.001 | 0.258 |
| 6 | Farm Turnover & Agricultural Region | P >0.008 | 0.191 |
| 7 | Farm Turnover & Number of Managers | P <0.000 | 0.325 |
| 8 | Farm Turnover & Size of Farm | P <0.001 | 0.209 |

Source: Derived from Survey Data, 2008; N=277

### 5.3.1. Age and Level of Education

Focusing on the relationship between age and education is useful in determining the criteria and policies that stakeholders should target for the conversion to organic farming in Libya. Moreover, age and education were reviewed in the literature review.

Correlation analysis was processed by recording the age and level of education. The age is recorded from 5 categories which are (30-40), (41-51), (52- 62), (63-73) and (74 and above) to 3 categories which are (30-51), (52-73), and (74 and above) (see table 5-5). Level of education is recorded from 6 categories which are (Formal training), (Primary school), (Secondary School), (High School), (University) and (Other) to 3 categories which are (Formal Training and others) , (Primary school and Secondary school and High School) and (University). A recorded process was important to avoid any statistical errors and to achieve significant findings between age and level of education. The finding shows that there is a significant relationship between age and level of education, which was (V= 0.292). Table 5.5 indicates that 35% of farmers aged 30 to 51 years have a university education whilst another 54% have primary, secondary and high school education. It also noted that 54% of farmers aged between 52 to 73 years have primary, secondary and high school education, whilst 15% of the same age have a university education. The table also shows that 24% of farmers aged 74 and above have primary, secondary and high school education whilst 6% in the same age group have university education. The table also indicates that farmers aged 74 years and above dominate the highest proportion (70%) of farmers who have formal training and other type of education. That is followed by farmers aged between 52 - 73 years (31%), followed by those aged 30-51 (11%). The implications of these findings are discussed in Chapter 7.

**Table 5.5 Cross-Tabulation of Age and Level of Education**

| | | LEVEL OF EDUCATION | | | | | | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| | | FORMAL TRAINING & OTHERS | | PRIMARY & SECONDARY & HIGH SCHOOL | | UNIVERSITY | | | |
| | | COUNT | % | COUNT | % | COUNT | % | COUNT | % |
| AGE | 30-51 | 11 | 10.7% | 56 | 54.4% | 36 | 35.0 | 103 | 100.0% |
| | 52-73 | 34 | 31.5% | 58 | 53.7% | 16 | 14.8 | 108 | 100.0% |
| | 74+ | 12 | 70.6% | 4 | 23.5% | 1 | 5.9 | 17 | 100.0% |
| | TOTAL | 57 | 25.0% | 118 | 51.8% | 53 | 23.2 | 228 | 100.0% |

Source: Derived from Survey Data, 2008; N=277

The findings shows a significant relationship between age and level of education; however, this was not strong (V=0.292). For example, the findings related to the age group 30–51 years are considered good in relation to the mean of the age (53 years). Therefore, farmers' ages for these categories were less than the mean of farmers aged 53.8 years. This means the youngest farmers in Libya have a higher level of education, which is relevant for stakeholders, as the finding from the literature is that younger and more educated famers are more likely to make the transformation to organic farming. A further positive point from the findings is that the oldest farmers in Libya were engaged with good education levels. Thus, 71% of the farmers aged 74 and above have a formal training in agriculture whilst 23 % have between primary and secondary and high school education. However, it was noted that of the oldest farmers aged over 74 years and above only 6% have a university education, whilst 15% of farmers aged between 52-73 years have a university education. This finding could indicate that the oldest farmers in Libya have the ability to understand new methods and approaches of agriculture such as organic farming. Despite the satisfactory level of education of the oldest farmers in Libya, however, the literature does not find that these farmers easily adopt organic farming. From the research findings, the researcher suggests that the categories 30-51 years might be the best ones to target for the transformation to organic farming in Libya.

### 5.3.2 Age and Agricultural Regions

Cross-tabulating age against agricultural region is useful in order to determine where the youngest farmers, who according to research are the most likely to take up organic farming, are situated. The finding indicates that there is a significant relationship between age and agricultural regions. This was ($P<0.001$, $V=0.236$). An analysis of the age of farmers in the various regions indicates that in the Algabal Al-kdar region, 35% of the farmers are below 51 years, in comparison to 40% in the Aljafara region and 63% in the Fazzan region. Therefore, the Fazzan region has a greater percentage of farmers who are relatively young, compared to the other regions. The results also shows that the Aljafara region has the highest number of oldest farmers, 26% of whom are aged 63 to 73 and about 12% of whom are 74 or over. In comparison, in the Algabal Al-kdar region, 24% are aged 63-73 but only 14% are in that age group in the Fazzan region. The Aljafara region also has the highest percentage of farmers aged 74 and above (12%), followed by the Fazzan region (5.5%) and the Algabal Al-kdar region (5.4%). See Table 5.6 for details.

Table 5.6 Cross-Tabulation of Agricultural Regions and Age

| | | AGE | | | | | | | | | | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 30-40 | | 41-51 | | 52-62 | | 63-73 | | 74+ | | | |
| | | COUNT | % | COUNT | % | COUNT | % | COUNT | % | COUNT | % | COUNT | % |
| AGRI-CULTURAL REGIONS | Algabal Al-kdar | 9 | 9.8% | 23 | 25.0% | 33 | 35.9% | 22 | 23.9% | 5 | 5.4% | 92 | 100 % |
| | Aljafara | 15 | 23.1% | 11 | 16.9% | 14 | 21.5% | 17 | 26.2% | 8 | 12.3% | 65 | 100 % |
| | Fazzan | 14 | 19.2% | 32 | 43.8% | 13 | 17.8% | 10 | 13.7% | 4 | 5.5% | 73 | 100 % |
| TOTAL | | 38 | 16.5% | 66 | 28.7% | 60 | 26.1% | 49 | 21.3% | 17 | 7.4% | 230 | 100 % |

Source: Derived from Survey Data, 2008; N=277

Overall, the result shows that farmers in the Fazzan region are the youngest farmers in the study sample and that the Aljafara region has the highest number of the oldest group farmers, who are above 63 years. The reasons for the results could be that the youngest farmers are in the Fazzan region because of those farmers' engagement in agriculture and due to the development of the agricultural sector. Therefore, it might be that in the last decade more people were engaged in agriculture in Fazzan than in the other regions, and the people who were engaged in agriculture were the youngest people. Furthermore, it might be due to the development and growth of the agriculture sector in Fazzan in the last decade, where there was more development and growth than in the Aljafara and Algabal Al-kdar regions. The Aljafara region has the highest number of older farmers. This result might indicate that agriculture was developed in the Aljafara region before that of the Algabal Al-kdar and Fazzan regions.

As the evidence suggests that young farmers are more likely to convert to organic farming, the results would suggest that stakeholders should target the Fazzan region. The Aljafara region has the highest level of older farmers, who according to research are more reluctant to switch to organic farming, and so policy-holders should consider giving less priority to this region.

### 5.3.3 Level of Education and Experience

Farmers who have a satisfactory level of education and sufficient experience are vital for agricultural operations, practices and development. Therefore, farmers' experience and education are positively related to the whole process of farming. For the purposes of this study it was determined that the sample should be restricted to farmers with 10 years or more of experience. The reasons for this selection are explained in the research methodology chapter.

The correlation analysis was processed by recording the level of experience from 5 categories which are (10-15), (16-21), (22-27), (28-33) and (34 and above) to 3 categories which are (10-21), (22-33), and (34 and above). In the recording process it was important to avoid any statistical errors and to achieve significant findings between farmers' experience and their level of education. A correlation analysis between the level of education and experience indicates that there is a significant, but weak, relationship between the two variables ($P< 0.000$, $V=0.265$). Table 5.7 shows that 62% of farmers with 10 to 21 years experience have a university education, whilst 18% have formal training. Moreover, 32% of farmers with 22 to 33 years experience have a university education, whilst 50% have formal training. However, just 6% of farmers aged

34 years and above have a university education and 31% of same category has formal training.

The table also shows that 52% of farmers with 10-21 years of farming experience have a high school education, whereas 39% of farmers with 22-33 years experience have a high school education and about 9 % of farmers with 34 years experience and above have a high school education. The finding also indicates that the highest proportion of formal training was reported with 50% of farmers with 22-33 years experience having formal training, followed by 31% of farmers with 34 years experience and above, and followed by 19% of farmers with 10-21 years experience.

**Table 5.7 Level of Education and Experience**

| | | EXPERIENCE | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| | | 10-21 | | 22-33 | | 34+ | | | |
| | | Count | % | Count | % | Count | % | Count | % |
| LEVEL OF EDUCATION | FORMAL TRAINING | 9 | 18.8% | 24 | 50.0% | 15 | 31.3% | 48 | 100.0% |
| | PRIMARY SCHOOL | 13 | 35.1% | 16 | 43.2% | 8 | 21.6% | 37 | 100.0% |
| | SECONDARY SCHOOL | 22 | 50.0% | 20 | 45.5% | 2 | 4.5% | 44 | 100.0% |
| | HIGH SCHOOL | 33 | 51.6% | 25 | 39.1% | 6 | 9.4% | 64 | 100.0% |
| | UNIVERSITY | 41 | 62.1% | 21 | 31.8% | 4 | 6.1% | 66 | 100.0% |
| | OTHER | 3 | 20.0% | 8 | 53.3% | 4 | 26.7% | 15 | 100.0% |
| Total | | 121 | 44.2% | 114 | 41.6% | 39 | 14.2% | 274 | 100.0% |

Source: Derived from Survey Data, 2008; N=277

The findings highlight an inverse relationship between years of experience and level of education: the less the experience, the higher the level of education. This finding supports other research reviewed in the literature on the conversion to organic farming and the adoption of new methods. The 2008 study conducted in Norway founded that the average experience of the organic famer was nearly 22 years, whereas the average for non-organic farmers was 25 years (Matthias *et al.,* 2008). Another study, carried out in Nigeria, showed that 56.7% of the organic farmers respondents had 6 to 10 years farming experience (Adesope *et al.,* 2008). Anim (1999) found that higher educated farmers tend to adopt organic farming methods more quickly than less educated ones. Furthermore, several studies from other countries have reported organic farmers to be better educated than their conventional counterparts (Padel, 2001). These empirical studies are supported by the Innovation theory, which states that innovators are better educated than later adopters and tend to have more social contacts outside their local community (Padel, 2001; Rogers, 1983).

The evidence suggests that the policy makers should target farmers who have obtained a high level of education and a reasonable degree of experience rather than a low level of education and high degree of experience.

### 5.3.4 Farm Ownership Structure and Farm Type

Assessing the relationship between farm type and ownership structure is important for understanding the way in which the types of crops produced are related to the ownership structure. The correlation analysis of farm type and ownership structure indicates that there is a significant relationship between the two variables, although this is weak ($P<0.000$; $V=0.237$). Table 5.8 shows that all dairy farms are owned by the farmers as well as 91% of livestock and 92% of mixed farms. However, 32% of horticultural farms are not owned by the farmers.

**Table 5.8 Cross-Tabulation of Farm Ownership and Farm Type**

| | | OWNERSHIP | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| | | OWNER | | TENANT | | OTHER | | | |
| | | count | % | count | % | count | % | count | % |
| FARM TYPE | DAIRY | 1 | 100.0% | 0 | 0.0% | 0 | 0.0% | 1 | 100.0% |
| | LIVESTOCK | 10 | 90.9% | 0 | 0.0% | 1 | 9.1% | 11 | 100.0% |
| | HORTICULTURE | 53 | 64.6% | 2 | 2.4% | 27 | 32.9% | 82 | 100.0% |
| | MIXED | 155 | 91.7% | 1 | 0.6% | 13 | 7.7% | 169 | 100.0% |
| | OTHER | 3 | 75.0% | 0 | 0.0% | 1 | 25.0% | 4 | 100.0% |
| | Total | 222 | 83.1% | 3 | 1.1% | 42 | 15.7% | 267 | 100.0% |

Source: Derived from Survey Data, 2008; N=277

The result shows there is a significant relationship between farm type and ownership. This result shows that the majority of farmers in Libya owned their farm. This means the farmers can make any decision in operating their farm easily. This seems to indicate that farmers in Libya have good opportunities and the choice to make the decision to convert to organic farming by themselves. However, 32% of horticultural farms, 9% of livestock farms and 25% of other farm types are owned by others, while 2% of horticulture farms are tenanted: it might not be easy for these farmers to make any decision about the conversion to organic as their relationship with the land is not so strong.

Thus, the findings are encouraging, as they support what the literature states about the importance of ownership. For example, Stroebel (2004) indicates that the availability of agricultural-related assets influences production and marketing decisions among smallholder farmers. This implies that farmers who own their farms have a greater influence on what to produce and where to market their produce than do those who do not own their farms. However, the findings of this research do not agree with the view of Ben Kheder (2001), who argues that ownership is one of the main obstacles to conversion to organic farming in Mediterranean countries. Therefore, uncertainties about ownership and access to land are a real obstacle to conversion. Farmers have to be sure that they will be able to benefit from investing.

### 5.3.5 Farm Type and Responsibility for Decision Making

Basically, responsibility for decision-making in farming is reflected in the farming operation and practices. The findings highlighted in Table 5.9 below indicate a significant relationship between the farmer's responsibility for making decisions about the practices and operations and the type of farm. This was ($P<0.000$;-V=0.258). This explained that more than 97% of other types of farmers, such as dairy, horticulture and mixed farms, were responsible for decision-making. However, in 27% of livestock farms, the farmers do not have responsibility for decision making.

Table 5.9 Cross-Tabulation of Farm Type and Responsibility for Decision Making

| | | RESPONSIBILITY FOR DECISION MAKING | | | | Total | |
|---|---|---|---|---|---|---|---|
| | | YES | | NO | | | |
| | | Count | % | Count | % | Count | % |
| FARM TYPE | DAIRY | 1 | 100.0% | 0 | 0.0% | 1 | 100.0% |
| | LIVESTOCK | 8 | 72.7% | 3 | 27.3% | 11 | 100.0% |
| | HORTICULTURE | 82 | 97.6% | 2 | 2.4% | 84 | 100.0% |
| | MIXED | 163 | 97.0% | 5 | 3.0% | 168 | 100.0% |
| | OTHER | 4 | 100.0% | 0 | 0.0% | 4 | 100.0% |
| Total | | 258 | 96.3% | 10 | 3.7% | 268 | 100.0% |

Source: Derived from Survey Data, 2008; N=277

This result indicates that most farmers in Libya have total responsibility for making decisions regarding farm operations and practices, as well as the farm business. This result is considered a good sign for development of the farming sector in Libya, especially when stakeholders introduce new agricultural methods or technology or implement agricultural policies. Therefore, the finding of this research is considered good motivation for farmers in Libya in carrying out their agricultural practices freely as stated by the Soil Association in the UK (Crucefix, 1998), which indicated that if farmers do not have title to their land, many will be reluctant to plant permanent crops. Obtaining title for reservation land is a long and complicated process. In addition, the findings of this research might encourage decision-makers as well as farmers to adopt and facilitate the conversion to organic without any difficulties.

### 5.3.6 Annual Farm Turnover and Agricultural Regions

Annual farm turnover reflects how much farmers earn from agriculture operations over one year; however, as stated previously, the researcher is concerned about the accuracy of the data related to turnover. Moreover, turnover is considered as a strong measure and a motivation for farmers to produce specific sorts of crops.

Correlation analysis processed by recorded Farm Annual Turnover was recorded from 10 categories, which are (LYD 1,000-5,999),(LYD 6000-11,999), (LYD 12,000-17,999), (LYD 18,000-23,999) (LYD 24,000-29,999), (LYD 30,000-35,999), (LYD 36,000-41,999), (LYD 42,000-47,999), (LYD 48,000-53,999), (LYD 54,000 and above) to 2 categories which are (1,000-29,999), (30,000 and above) see table 5.10. The recording process was important to avoid any statistical errors and to achieve significant findings between Farm Annual Turnover and Agricultural Regions.

The analysis shows that there is a significant statistical relationship between farm annual turnover and agricultural regions as (P< 0.001, V=0.191). The finding indicates that turnover in the Algabal Al-Akdar region is higher than in the Aljafara and Fazzan regions. For example, 71% farmers in the Algabal Al-Akdar region earn LYD 30,000 and above, compared to 23% in the Fazzan region and 6% in the Aljafara region. The table also indicates that aging turnover in the Algabal Al-Akdar region was the highest (34.4%) with farmers earning between 1,000-29,999, followed by the Fazzan region (34.0%) and Aljafara (32%) respectively. The findings also show that farmers in the Fazzan region farmers earn more than those in the Aljafara region, in all categories of earning, whereas the Algabal Al-Akdar region was the best in earning categories compared with the Fazzan region and the Aljafara region.

**Table 5.10 Cross-Tabulation of Farm Turnover and Agricultural Region**

| | | AGRICULTURAL REGIONS | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| | | Algabal Al-kdar | | Aljafara | | Fazzan | | | |
| | | Count | % | Count | % | Count | % | Count | % |
| TURNOVER 2 | 1,000-29,999 | 86 | 34.4% | 79 | 31.6% | 85 | 34.0% | 250 | 100.0% |
| | 30,000+ | 12 | 70.6% | 1 | 5.9% | 4 | 23.5% | 17 | 100.0% |
| | Total | 98 | 36.7% | 80 | 30.0% | 89 | 33.3% | 267 | 100.0% |

Source: Derived from Survey Data, 2008; N=277

It is known that many factors play an important role in agricultural production, such as fertility of soil, quality of water, availability and accessibility to agricultural infrastructure, the quality of agricultural inputs, farm size and farm type. Thus, the higher turnover in the Algabal Al-kdar region can be attributed to the better quality of soil and the improved availability of water, especially rainfall. It would suggest that the reason why farmers' earnings in the Fazzan region are better than in the Aljafara region could be due to the development of agriculture in the region in recent years, as a result of new farm establishment. This means that the soil in Fazzan is still in good condition because a high proportion of farms in Fazzan were only established in recent years.

Turnover is considered to be one of the motivations that could encourage farmers to convert to organic farming. This is supported by previous studies about financial motivation that show that recent adaptors have been attracted to organic farming because of financial motives rather than non-economic concerns (see for instance, Laten et al., 2006; Padel, 2001).

### 5.3.7 Turnover and Number of Farm Managers

Cross-tabulating turnover and farm managers, highlights the extent to which turnover is affected by the number of managers. In turn this is defined by the number of people working on the farm, including both labourers and managers. For this research, investigating this issue is important, in order to be able to suggest the policies and criteria that should be targeted to assist with the conversion to organic farming in Libya.

Correlation analysis processed by recorded Farm Annual Turnover was recorded from 10 categories, which are (LYD 1,000-5,999),( LYD 6000–11,999), (LYD 12,000-17,999), (LYD 18,000-23.999), (LYD 24,000-29,999), (LYD 30,000-35,999), (LYD 36,000-41,999), (LYD 42,000-47,999), (LYD 48,000-53,999), (LYD 54,000 and above) to 2 categories which are (LYD 1,000-29,999), (LYD 30,000 and above). Furthermore, the number of people who manage the farm was recorded as well from 4 categories which are (1-3), (4-6), (7-9) and (10-12) to 2 categories which are (1-6) and (7-12). Recording the process was important to avoid any statistical errors and to achieve significant findings between Farm Annual Turnover and Agricultural Regions.

The analysis shows that there was a significant relationship between turnover and the number of managers; this was shown as ($P<0.000$, $V=0.325$). Table 5.11 shows that 95 % of farms with 1 to 6 managers have a turnover of LYD 1,000 to LYD 29,999. However, this was only for 5% farms, with 7 to 12 managers. The finding also shows that 65% of farms with 1 to 6 managers have a turnover of 30,000 and above, whilst 35% of farms with 7 to 12 managers have a higher turnover of 30,000 and above.

**Table 5.11 Cross-tabulation of Farm Turnover and Number of Managers**

| | THE NUMBER OF PEOPLE WHO MANAGE THE FARM RECORDs | | | | Total | |
|---|---|---|---|---|---|---|
| | 1-6 | | 7-12 | | | |
| | Count | % | Count | % | Count | % |
| TURNOVER RECORD 2 | | | | | | |
| 1,000-29, 999 | 185 | 95.4% | 9 | 4.6% | 194 | 100.0% |
| 30.000+ | 11 | 64.7% | 6 | 35.3 | 17 | 100.0% |
| Total | 196 | 92.9% | 15 | 7.1% | 211 | 100.0% |

Source: Derived from Survey Data, 2008; N=277

However, it is not just the number of managers that affects the level of turnover but other factors such as farm size, soil, access to water, farmers' experience, use of agricultural inputs and technologies, and agricultural infrastructure availability and accessibility. Nevertheless, the finding of a direct positive relationship between the number of managers and turnover does not support the literature findings as stated by Hoppe *et al.* (2007), who argue that higher-value agricultural products are typically produced on large farms due to higher labour requirements and the necessary marketing expertise (Hoppe *et al.*, 2007). According to the finding of this study, it would suggest that the best criteria of farm managers with farm annual turnover are 1-6 managers have a turnover of 30,000 and above. This finding needs more investigation to address exactly what the important factors are that affect this relationship.

### 5.3.8 Annual Turnover and Farm Size

Turnover is usually related to farm size but can also be affected by other factors that play an important role in agricultural processes; these factors include climate, quality of soil, quality of and access to water, agricultural inputs and the availability and accessibility of infrastructure. Focusing on this issue is vital for identifying which combination of farm size and turnover is best targeted for conversion to organic farming.

Correlation analysis processed by recorded Farm Annual Turnover was recorded from 10 categories which are (1000-5,999 LYD),(6000–11,999 LYD), (12,000-17,999 LYD), (18,000-23,999 LYD), (24,000-29,999 LYD), (3000-35,999 LYD), ( 36,000-41,999 LYD), (42,000-47,999 LYD), (48,000-53,999 LYD), ( 54,000 and above LYD) to 2 categories which are (1,000-29,999) and (30,000 and above). Farm size was recorded as well from 6 categories which are (5-15), (16-26), (27-37) and (38-48), (49-59), (60 and above) to 2 categories which are (5-37) and (38-60+). The recorded process was important to avoid any statistical errors and to achieve significant findings between Farm Annual Turnover and Farm Size.

The analysis shows that there was a significant relationship between turnover and farm size, which was ($P< 0.001$, $V=0.209$). Table 5.12 shows that 93% of farms sized between 5 and 37 ha have earned LYD 1,000 to 29,999, whilst 7% of farms sized between 38 and 60+ ha have earned LYD 1,000 to 29,999. The table also shows that 69% of farms sized between 5-37 ha have earned LYD 30,000+, whilst 31% of farms sized between 38-60+ ha have earned LYD 30,000.

The analysis shows that there was a significant statistical relationship between turnover and farms sized between 5 and 37 ha. As expected, 69% of the famers reporting the lowest turnover (LYD 30,000) had the smallest farms (5-37 hectares). However, 31% of farms with 38 to 60 hectares had higher turnovers of 36,000 LYD and above (see Table 5.12).

Table 5.12 Cross-Tabulation of Annual Turnover and Farm Size

| | FARM SIZE RECORD | | | | Total | |
|---|---|---|---|---|---|---|
| | 5-37 | | 38-60+ | | | |
| | Count | % | Count | % | Count | % |
| **TURNOVER RECORD 2** | | | | | | |
| 1,000-29, 999 | 223 | 92.9% | 17 | 7.1% | 240 | 100.0% |
| 30.000+ | 11 | 68.8% | 5 | 31.3% | 17 | 100.0% |
| Total | 196 | 92.9% | 15 | 7.1% | 211 | 100.0% |

Source: Derived from Survey Data, 2008; N=277

However, it would suggest that the conditions and factors that affect the increasing farm annual turnover need to be addressed. Therefore, this it supported by the statement that under optimal management and pasture conditions, small-scale resettlement farmers can generate incomes on their allocated units. However, the incomes are very small (Schuh *et al.*, 2006). This finding seems to suggest that increasing the annual turnover for the small farms which less than 37 hectares in this study could happen under optimal management and pasture conditions. Therefore, according to the finding of this research it would suggest that farms with less 37 ha more profitable .Therefore, farms sized with less than 37 ha more appropriate for conversion to organic than other farms size.

### 5.4. Availability of Agricultural Infrastructure

Availability of infrastructure is one of the most important factors for growth and development in the agricultural sector. The development of the agricultural sector, reviewed in Chapters 2 and 3, explains the roles of six types of agricultural infrastructures: roads; communication and information services; processing infrastructure; irrigation and access to water; agriculture and research extension services; and credit and financial institutions. This chapter presents the analysis of the data about the availability of these six types of infrastructure. The aim of this section is to examine the level access of the farmers in the region to agricultural infrastructure, and thereby to understand how the level of infrastructure affects agricultural development in Libya. For the purpose of explanation, only valid percentage is used for this study: the missing number of the respondents is clarified in Table 5.13, as is the level of availability.

### 5.4.1 Roads

Ninety six of the respondents indicate that their farms have access to roads at the regional level but these do not extend into the farms. Only 4% have roads inside the farms. This result indicates that road infrastructure across the regions is high, whereas the availability of roads within the farms is low. This result it affects many inputs and outputs of agriculture which reviewed in Chapter 3.

### 5.4.2 Communication and Information Services

Communication and information services infrastructure is fundamental to the development of agriculture and can be made possible through IT. Communications play a major role in increasing agricultural produce and knowledge of farmers on agricultural practices.

#### 5.4.2.1 Telephone Services

Sixty-five percent of respondents indicated their farms have telephone services whilst 35% have access to telephone services regionally. Therefore, this result means that more than half of farms are in a position to more easily deal with agricultural inputs and outputs and can more easily receive information

#### 5.4.2.2 Fax Services

Ninety-one percent of the farms have access to fax services regionally, with only 9% having access on their farms. This result indicates that fax services are not considered important for agriculture in the regions under study.

#### 5.4.2.3 Mobile Ccommunication Services

Ninety percent of farms have mobile communication services available on the farm, while the remaining 10% can access them at the regional level. This finding indicates that almost farmers are familiar with mobile services. This penetration of the highest level of communication can facilitate agricultural activities.

#### 5.4.2.4 Internet Services

Fifty-five of farms have access to the internet available at the regional level, while 45% have internet services available on their farms. However, 237 of the 277 respondents did not answer the question about the availability of internet. This result indicates that farmers are not familiar with the internet, which might be because of a lack of interest by farmers about it.

### 5.4.3 Processing Iinfrastructure

#### 5.4.3.1 Food Processing Infrastructure

Ninety-six percent of the farms (out of 45) have access to food processing infrastructure at the regional level, with only 4% having access on the farm. 232 of respondents out of 277 did not answer the question about the availability of processing food infrastructure. Thus, this result indicates that level of availability of food processing infrastructure on the farm and in the region is very low and that farmers' understanding of food processing infrastructure is also low.

#### 5.4.3.2 Waste Processing Infrastructure

Waste processing infrastructure is available at the regional level to 93% of farms; while it is available to only 7% at the farm level. Again, most respondents did not answer this question (249 out of 277). This might be due to the lack of knowledge about waste processing, which gives a negative indication about farmers' concerns about environmental issues in agriculture and organic farming principles.

### 5.4.4 Irrigation Systems and Public Access to Water Availability

#### 5.4.4.1 Sources of Water

##### *5.4.4.1.1 Rainfall*

Eighty percent of farms use rainfall water from irrigation systems provided on their farms to irrigate their crops, while 20% of farms are irrigated by rainfall water provided at the regional level. This result indicates that 80% of respondents that answered this question have farms located on rainfall strip, while 20% of farms are located near to the rainfall strip.

*5.4.4.1.2 Water Wells*

Twenty-three percent of farms get their source of irrigation water from wells which are based on the farms, while 77% of farms are irrigated by water from wells which based in the regional level. This finding indicates that most farms are supplied by water from the wells which are located inside the farm. Farms which are supplied by water from the region are a greater risk from an interruption to supply than those which have access to wells on the farm.

*5.4.4.1.3 Recycled Water*

Re-cycled water sources are available to 23% farms at the farm level, while it is available to 77% at the region level. However, it is worth noting that 255 of respondents did not respond to this question. This result indicates that this sort of source of water is not important for agriculture sector.

### 5.4.4.2 Irrigation Systems

*5.4.4.2.1 Drip Irrigation*

Drip irrigation systems are available to 89% farms at the farm level, while it is available to 11% at the regional level. This result indicates that drip irrigation is dominated use as irrigation system in farms in the research sample.

*5.4.4.2.2 Sprinkler Irrigation*

Most of the farms 88% have sprinkler irrigation systems, while 12% of respondents answered that sprinkler irrigation is available to them at the regional level. This finding indicates that farmers are familiar with using sprinkler irrigation systems in the study's agricultural regions.

*5.4.4.2.3 Conventional Irrigation*

The analysis shows that conventional irrigation systems are available in 89% of farms at the farm level and 11% of farms at the regional level. 115 out of 277 respondents did not answer this question. This result indicates that conventional irrigation is still used by farmers in the study's agricultural regions. This result implies that farmers are still not aware about the limitation of water in Libya.

## 5.5 Research and Extension Services

### 5.5.1 Research Centres

Twenty-three percent of respondents (66 out of 277) indicate their awareness that research centres are available at the region level, while 77% did not answer this question. This indicates a lack of awareness of the research centres.

### 5.5.2 Training Centres

Ten percent of respondents (29 out of 277) indicate their awareness that training centres are available at the region level but 90% did not answer this question. This indicates a lack of awareness of the training centres.

### 5.5.3 Extension Services

Fifty-seven percent of respondents (160 out of 277) indicate their awareness that extension services are available at the region level, highlighting a greater awareness amongst farmers for this than training centres and research centres.

## 5.6. Credit and Financial Institutions

### 5.6.1 Agricultural Banks

Most of the respondents (203 out of 277) indicate that agricultural banks are available to them at the region level, while, 27% of respondents did not answer the question. Nevertheless this shows a strong awareness of the existence of agricultural banks.

### 5.6.2 Commercial Banks

Only 76 out of 277 of the respondents indicate that commercial banks are available to them at the region level, while 73% of the respondents did not answer this question. This indicates a lack of awareness over the usefulness f commercial for assisting farmers, when compared with agricultural banks.

**Table 5.13 Infrastructure Availability of Respondents**

| | Infrastructure | Level of Availability | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Farm | | Regional | | Total number of respondents out of 277 | Total number of non respondents out of 277 | % of non respondents |
| | | No of Respondents | % | No of Respondents | % | | | |
| 1 | Roads | 10 | 4 | 262 | 96 | 272 | 5 | 1.8 |
| 2 | Fixed Telephone | 121 | 65 | 64 | 35 | 185 | 92 | 33 |
| 3 | Fax services | 2 | 9 | 21 | 91 | 23 | 254 | 91 |
| 4 | Mobile Telephone | 209 | 90 | 23 | 10 | 232 | 45 | 16 |
| 5 | Internet services | 18 | 45 | 22 | 55 | 40 | 237 | 85 |
| 6 | Food processing | 2 | 4 | 43 | 96 | 45 | 232 | 84 |
| 7 | Waste Processing | 2 | 7 | 26 | 93 | 28 | 249 | 90 |
| 8 | Rainfall Water | 101 | 79.5 | 26 | 20.5 | 127 | 150 | 54 |
| 9 | Well-Water sources | 222 | 85 | 40 | 15 | 262 | 15 | 5 |
| 10 | Re-used water sources | 5 | 23 | 17 | 77 | 22 | 265 | 95 |
| 11 | Drip Irrigation | 114 | 89 | 14 | 11 | 128 | 149 | 54 |
| 12 | Sprinkler Irrigation | 167 | 88 | 23 | 12 | 190 | 87 | 31 |
| 13 | Conventional Irrigation | 109 | 89 | 13 | 11 | 122 | 155 | 56 |
| 14 | Research Centres | - | - | 65 | 100 | 65 | 212 | 76 |
| 15 | Training Centres | - | - | 29 | 100 | 29 | 248 | 89 |
| 16 | Extension services | - | - | 160 | 100 | 160 | 117 | 42 |
| 17 | Agricultural Banks | - | - | 203 | 100 | 203 | 74 | 27 |
| 18 | Commercial Banks | - | - | 76 | 100 | 76 | 201 | 73 |

Source: Derived from Survey Data, 2008; N=277

## 5.7 Agricultural Infrastructure Accessibility

It has been clarified from the literature review that accessibility to agricultural infrastructure services in a country improves the success of the agricultural sector, which in turn helps to determine the level of the country's economic development. Infrastructure accessibility is reviewed in Chapter 3, following a discussion in Chapter 2 on the development of infrastructure and its links to agricultural development in Libya.

This section analyzes the accessibility of farmers to agricultural infrastructure in Libya. The purpose is to provide a context for evaluating the influence of accessibility of agricultural infrastructure on agricultural development in Libya. For the purpose of explanation, only the valid percent is used for this study. The numbers of missing respondents for each question, along with the level of accessibility, is clarified in Table 5.14.

### 5.7.1 Road Transportation Accessibility

Twenty-five percent of the respondents indicate that accessibility to the road transportation systems to and from their farms was difficult, 39% held a neutral opinion about accessibility to transportation systems and 35% indicate that access was easy to transportation. This result indicates that road transportation accessibility still needs to improve.

### 5.7.2 Communication and Information Accessibility

More than one-third of the respondents 37% indicate that accessibility to communication and information infrastructure was easy, whilst a greater percentage 39% said they are neutral about accessibility to communication and information accessibility, and 20% indicate that it was difficult to access communication and information facilities. This result indicates that communication and information accessibility needs to improve especially for those that reported difficulties.

### 5.7.3 Processing Accessibility

Only a small proportion 2% of the respondents found the accessibility to the processing facilities easy and 46% found it difficult. A further 46% said they are neutral on accessibility to processing infrastructure from their farms. This finding indicates that almost farmers faced a real problem with accessibility to processing infrastructure systems. The difficulties are likely to impact negatively on agricultural output.

### 5.7.4 Agricultural Research and Extension Accessibility

Sixty percent of farmers found the accessibility to agricultural research and extension services difficult, although 3% indicated that accessibility to such services was easy, 12% are neutral and 25% reported no opinion. This result indicates that farmers are facing real problems with accessing agricultural research and extension services. This result shows that the link between farmers and the provision of agricultural research and extension services is weak.

### 5.7.5 Irrigation and Public Access to Water Accessibility

Irrigation and public access to water is easily available to 19% of the farmers, while 37% have difficulty in accessing such a service. 42% of respondents are neutral. This finding indicates that in general farmers face difficulties with accessibility to irrigation and public access to water. This is important because of the need for water to improve output.

### 5.7.6 Credit and Financial Institution Accessibility

Credit and financial institutions are easily accessible to 7% of the farmers, while 57% of farmers have difficulties in accessing such services. This finding indicates that farmers face real difficulties which can affect the efficiency of agricultural activities in Libya.

### 5.7.7 Market Accessibility

Markets are easily accessible to 20% of the farmers, while 36% have difficulties in accessing markets and 42% are neutral in their opinion. This result shows that markets are still insufficiently developed for farmers. This may be due to many factors, such as the provision of roads.

Table 5.14 Infrastructure Accessibility of Respondents

| Infrastructure | Level of Accessibility | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Easy | | Neutral | | Difficult | | Don't Know | | Total no of Respondents out of 277 | Total no of non Respondents out of 277 | % of non Respondents |
| | No of Respondents | % | No of Respondents | % | No of Respondents | % | No of Respondents | % | | | |
| Roads | 97 | 35 | 107 | 39 | 69 | 25 | 2 | 1 | 275 | 2 | 0.7 |
| Communication And Info. Systems | 98 | 37 | 104 | 39 | 54 | 20 | 11 | 4 | 267 | 10 | 4 |
| Processing Systems | 4 | 2 | 13 | 6 | 46 | 36 | 99 | 46 | 215 | 62 | 23 |
| Research And Extension Services | 7 | 3 | 29 | 12 | 145 | 60 | 61 | 25 | 242 | 35 | 13 |
| Irrigation And Public Access To Water | 52 | 19 | 114 | 42 | 101 | 37 | 3 | 1 | 270 | 7 | 2 |
| Credit And Financial Institutions | 19 | 7 | 71 | 27 | 147 | 57 | 22 | 8 | 259 | 18 | 6.5 |
| Markets | 51 | 19.5 | 109 | 42 | 95 | 36 | 7 | 3 | 262 | 15 | 5 |

Source: Derived from Survey Data, 2008; N=277

## 5.8 Agricultural Infrastructure Satisfaction Levels

This section analyzes the satisfaction levels of farmers with the availability of agricultural infrastructure in Libya. Distribution technique is used to analyze the degrees of satisfaction (satisfied/neutral/dissatisfied) with the current availability of agricultural infrastructure. The level of the availability and accessibility and farmer's experience determine of farmers stratification. For the purpose of explanation, only the valid percent is used for this study. The number of missing responses, along with the levels of satisfaction is highlighted in Table 5.15.

### 5.8.1 Roads

On the issue of level of satisfaction with the current agricultural roads infrastructure in Libya, 45% of respondents indicate they are satisfied. Twenty-eight percent of respondents indicate their dissatisfaction and an almost equal number 27% stated they are neutral. The result, with less than 50% of satisfaction about roads, implies that the provision of roads is still not sufficient for agricultural operations in the agricultural regions.

### 5.8.2 Communication and Information services

#### 5.8.2.1 Telephone Communication

Sixty-one percent of respondents were satisfied with telephone communication infrastructure in Libya. 22% of respondents are neutral abut their level of satisfaction with telephone communication infrastructure and 17% of respondents are dissatisfied. This finding indicates that the level of accessibility and availability of this infrastructure is reasonable for farmers in their daily farming operations.

#### 5.8.2.2 Fax Communication

Nearly half of the respondents, 48%, are dissatisfied with fax communication infrastructure in Libya, while 41% are satisfied and 10% are neutral. However, 248 respondents did not answer this question. Although the results indicate that farmers are not satisfied with the fax services the lack of responses indicates that fax services are not important for farming in the agricultural regions.

#### 5.8.2.3 Mobile Communication

Most respondents (71%) reported they are satisfied with mobile communication infrastructure while 22% of respondents are neutral as to their level of satisfaction. Only 8% are dissatisfied with mobile communication systems. This finding indicates that farmers in the study are familiar with using mobile in their agricultural activities.

#### 5.8.2.4 Internet Communication

Forty-one percent of farmers are satisfied with internet communication infrastructure in Libya and 37% are neutral in their satisfaction, while 22% are dissatisfied. However, 226 out of 277 respondents did not answer this question.

This result could indicate that farmers are not aware or fail to understand the positive impact of internet services on the farm operations. However, the explanation might also be due to the inadequate level of the availability of and accessibility to internet services infrastructure in Libya.

### 5.8.3 Processing Infrastructure

#### 5.8.3.1 Food Processing Infrastructure

Most farmers (86%) are dissatisfied with food processing infrastructure in Libya. Only 4% of farmers are satisfied. However, 164 out of 277 respondents did not answer this question, which may be due to the weak role of food processing infrastructure in the agriculture sector in Libya.

#### 5.8.3.2 Waste Processing Infrastructure

Only 1% of farmers are satisfied with the current waste processing infrastructure, while 94% are dissatisfied. However, 178 out of 277 farmers did not answer this question. The fact that most farmers are not satisfied could be due to the lack awareness about the importance of this sort of infrastructure and/or due to the low level of availability and accessibility of waste processing infrastructure.

### 5.8.4 Irrigation and Public Access to Water

#### 5.8.4.1 Sources of Water

*5.8.4.1.1 Irrigation From Well Water*

Nearly half, 46%, of respondents indicate they are satisfied with irrigation systems that use well-water as their source of supply. 30% indicate they are neutral as to the level of satisfaction while 24% are dissatisfied. This result indicates that around half the farmers face a problem with a level of well water supply.

*5.8.4.1.2 Rainfall*

Nearly half, 47%, of respondents are neutral with the level of satisfaction about rainfall, while 41% of respondents indicate that they are satisfied with the level of rainfall. Only 12% are dissatisfied with the level of rainfall. However, 146 out of 277 respondents did not answer this question. This result implies the level of rainfall in the rain strip region. The level of rainfall is not controlled by human beings. However, the low level of rainfall in Libya could impact on the responses which reflected farmers' answers as dissatisfied.

*5.8.4.1.3 Water Sanitation*

Most respondents (82%) are dissatisfied with the level of water sanitation, while 9% are satisfied and a further 9% are neutral. However, 188 out of 277 respondents did not answer this question. The results indicate that there was no role for this source of water in agricultural development.

*5.8.4.1.4 Irrigation Using Recycled Water*

Most respondents, (84%), indicate they are dissatisfied with access to recycled water via irrigation systems and 15% are satisfied with the level of recycled water. However, 212 out of 277 respondents did not answer this question. This finding shows that farmers are not familiar with this type of irrigation.

#### 5.8.4.2 Irrigation Systems

*5.8.4.2.1 Drip Irrigation Systems*

Two-thirds of respondents (66%) indicate that they are satisfied with drip irrigation systems while 24% are neutral with their level of satisfaction and 11% are dissatisfied. One hundred and thirty-eight out of 277 respondents did not answer this question. Although almost half the respondents did not answer the question, the result indicates that drip irrigation system still not available enough in the study regions.

*5.8.4.2.2 Sprinkler Irrigation Systems*

Sixty-two percent of respondents indicate that they are satisfied with sprinkler irrigation systems, while 30% indicate they are neutral and 9% are dissatisfied. The result shows that the level and the availability of sprinkler irrigation system in the regions were sufficient to meet the needs of most farmers. Furthermore, the result shows farmers are familiar with sprinkler irrigation systems.

*5.8.4.2.3 Conventional Irrigation Systems*

Forty-four percent of respondents are satisfied with conventional irrigation systems while 29% are dissatisfied and 27% are neutral. However, 150 out of 277 respondents did not answer this question. This result indicates that the 29% of farmers who are dissatisfied are aware of the limits to water supply and they understand that conventional irrigation systems are not the best solution.

### 5.8.5 Agricultural Research and Extension Services

#### 5.8.5.1 Research centres

Only 8% of respondents are satisfied with the services of research and extension research centres, while 81% of respondents are dissatisfied with research centres, but 107 out of 277 respondents did not answer this question. The result clearly indicates that farmers are not satisfied with research and extension research centres which might to the degree of availability and accessibility.

#### 5.8.5.2 Agricultural Training Centres

Seven percent of respondents are satisfied with services provided by agricultural training centres while 82% of respondents are dissatisfied. However, 152 out of 277 respondents did not answer this question. The reason most farmers did not response of this question may be due to the small role of services provided by agricultural training centres.

#### 5.8.5.3 Extension Services

Only 6% of respondents indicate their satisfaction with extension services, while 75% are dissatisfied with the services. The reason for the high level of dissatisfaction is due to the small role of services provided by extension services centres.

### 5.8.6 Agricultural Credit and Financial Institutions

#### 5.8.6.1 Agricultural Banks

Sixteen percent of respondents are satisfied with the services of agricultural banks while 57% of the respondents are dissatisfied and 27% are neutral with the banks' services. The low level of satisfaction is due to the lack of the agricultural banks' role in agricultural development.

#### 5.8.6.2 Commercial Banks

Seventeen percent of respondents are satisfied with the services of credit and financial institution such as commercial banks, while 52% are dissatisfied and 30% are neutral as to their services. However, 162 out of 277 respondents did not answer this question. The lack of response may be due to the lack of the role of commercial banks in agricultural sector.

**Table 5.15 Farmers' Satisfaction with Infrastructure of Respondents**

| Infrastructure | Level of Satisfaction | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Satisfied | | Neutral | | Dissatisfied | | Total no of respondents out of 277 | total no of non respondents out of 277 | % no of non respondents |
| | No of Respondents | % | No of Respondents | % | No of Respondents | % | | | |
| **Roads** | 123 | 45 | 74 | 27 | 76 | 28 | 273 | 4 | 1 |
| Telephone | 117 | 61 | 43 | 22 | 33 | 17 | 193 | 84 | 30 |
| Fax | 12 | 41 | 3 | 10 | 14 | 48 | 29 | 248 | 89.5 |
| **Mobile** | 157 | 71 | 48 | 22 | 17 | 8 | 222 | 55 | 20 |
| Internet | 21 | 41 | 19 | 37 | 11 | 22 | 51 | 226 | 82 |
| Food Processing infrastructure | 5 | 4 | 11 | 10 | 97 | 86 | 113 | 164 | 59 |
| Waste Processing infrastructure | 1 | 1 | 5 | 5 | 93 | 94 | 99 | 178 | 64 |
| Access to well water | 123 | 46 | 79 | 30 | 64 | 24 | 266 | 11 | 4 |
| Rainfall | 54 | 41 | 62 | 47 | 15 | 12 | 131 | 146 | 53 |
| Water sanitation | 8 | 9 | 8 | 9 | 73 | 82 | 89 | 188 | 68 |
| Access to re-use water | - | - | 10 | 15 | 55 | 85 | 65 | 212 | 76 |
| Drip Irrigation | 91 | 65.5 | 33 | 24 | 15 | 11 | 139 | 138 | 50 |
| Sprinkler Irrigation | 109 | 62 | 53 | 30 | 15 | 8.5 | 177 | 100 | 36 |
| Conventional Irrigation | 56 | 44 | 34 | 27 | 37 | 29 | 127 | 150 | 54 |
| Agricultural research centres | 13 | 8 | 20 | 12 | 137 | 80 | 170 | 107 | 39 |
| Training centres | 9 | 7 | 13 | 10.5 | 103 | 82.5 | 125 | 152 | 55 |
| Extension services | 12 | 6 | 35 | 19 | 141 | 75 | 188 | 89 | 32 |
| Agricultural banks | 37 | 16 | 64 | 27 | 133 | 57 | 234 | 43 | 15.5 |
| Commercial banks | 20 | 17.5 | 35 | 30.5 | 60 | 52 | 115 | 162 | 58.5 |

Source: Derived from Survey Data, 2008; N=277

## 5.9 Farmers' Choice of Produce and Infrastructure Availability

This section analyzes the relationship between the availability of agricultural infrastructure and the choice of produce by farmers. A distribution technique is used to analyze the relationship based on a range of responses: very strong; strong; neutral; weak; and not at all. These reactions to the effect on choice of produce is tested against the types of available infrastructure in the agricultural regions including road transportation, communication and information services, processing infrastructure, irrigation and public access to water, agricultural research and extension services, credit and financial institutions, and access to markets. For the purpose of explanation, only the valid percent is used for this study. However, the number of missing respondents is clarified in Table 5.16, which also gives details of the responses.

### 5.9.1 Road Transportation

Thirty-six percent of the respondents indicate that their choice of produce is very strongly influenced by available road infrastructure and a further 28% state are their choice is strongly influenced by available road infrastructure, while 20% are neutral. This result indicates that road infrastructure has a strong impact on farmers' choice of produce in the region.

### 5.9.2 Communication and Information Services

Twenty-three percent of the respondents indicate that their choice of produce is very strongly influenced, a further 25% state that it is strongly influenced by the availability of communication and information systems, and 26% indicate their choice of produce is neutrally affected. On the other hand, only 14% state their choice of produce is weakly influenced and 12% that their choice is not influenced by the availability of communication and information systems. The result shows that communication and information services affect farmer's choice of produce by 74%.

### 5.9.3 Processing Infrastructure

Twenty-four percent of farmers are influenced very strongly and about 12% are influenced strongly in their choice of produce by the availability of processing facilities. On the other hand, 22% indicate that their choice of produce is weakly influenced by the availability of processing infrastructure and about 30% of the respondents indicate that their choice of produce was not at all influenced by the availability of processing infrastructure. This result that the majority of farmers are not influenced strongly or very strongly by the availability of processing infrastructure in place may be due to the lack of the availability, accessibility and quality of processing infrastructure.

### 5.9.4 Irrigation and Public Access to Water

The choice of produce of half of the farmers (51%) is influenced very strongly and 22% are strongly influenced by the availability of public access to water irrigation systems. Only 6% of the respondents are weakly influenced. As water is the most important factor for agriculture it directly influences the farmer's choice of produce. Therefore, the findings confirm that the vast majority of farmers are aware of the importance of availability of public access to water irrigation systems in agricultural operations.

### 5.9.5 Agricultural Research and Extension Services

The choice of produce of 22% of farmers is influenced very strongly by the availability of agricultural research and extension services but about 27% of the respondents are only weakly influenced by their availability and 21% are not at all influenced in their choice of produce. The reason that nearly half of the farmers are not influenced in their choice of produce by the availability of agricultural research and extension services is due to the weak engagement of the agricultural research and extension services in agricultural activities.

### 5.9.6 Credit and Financial Institutions

Twenty-nine percent of the respondents indicate that their choice of produce of is very strongly influenced by the availability of credit and financial institutions, while a further 19% indicate that their choice of produce is strongly influenced by the availability of credit and financial institutions. However, 18% indicate that that their choice of produce of is not at all influenced by the availability of credit and financial institutions. This finding indicates that the availability of financial institutions was involved in the development of agriculture in the way of farmers' choice of produce by 81% of respondents.

### 5.9.7 Markets

The choices of produce of 48% of farmers are very strongly influenced by the available markets and a further 21% are strongly influenced by the available markets. Only 4.5% are not at all influenced by the available markets. Although the majority are influenced by the markets, the overall level of influence is not as strong as would be expected.

**Table 5.16 Infrastructure on Farmer's Choice of Produce of Respondents**

| Infrastructure | Level of Influence of Infrastructure and Farmers' Choice of Produce | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Very Strong | | Strong | | Neutral | | Weak | | Not at All | | Total no of respondents out of 277 | total no of non respondents out of 277 | % no of non respondents |
| | No of Respondents | % | No of Respondents | % | No of Respondents | % | No of Respondents | % | No of Respondents | % | | | |
| Roads | 96 | 36 | 74 | 28 | 54 | 20 | 24 | 9 | 19 | 7 | 267 | 10 | 4 |
| Communication And Info. Systems | 60 | 23 | 64 | 25 | 67 | 26 | 36 | 14 | 31 | 12 | 258 | 19 | 7 |
| Processing Systems | 56 | 24 | 29 | 12 | 29 | 12 | 51 | 22 | 69 | 29 | 234 | 43 | 15 |
| Research And Extension Services | 55 | 22 | 33 | 13 | 44 | 16 | 69 | 27 | 52 | 21 | 253 | 24 | 9 |
| Irrigation And Public Access To Water | 136 | 51 | 58 | 22 | 46 | 17 | 15 | 6 | 12 | 4.5 | 267 | 10 | 4 |
| Credit And Financial Institutions | 76 | 29 | 50 | 19 | 42 | 16 | 44 | 17 | 48 | 18.5 | 260 | 17 | 6 |
| Markets | 127 | 48 | 56 | 21 | 40 | 15 | 31 | 12 | 12 | 4.5 | 266 | 11 | 4 |

Source: Derived from Survey Data, 2008; N=277

## 5.10 Infrastructure and the use of Agriculture Inputs

Increasing yield productivity plays a major role in the ability of agriculture to supply a country's food requirements. Using agricultural inputs can lead to an increase in yield productivity in the agricultural sector. Agricultural infrastructure plays an important role in the use of inputs into agricultural production. This section assesses the relationship between the availability of agricultural infrastructure and agricultural inputs, such as chemical fertilizer, manure fertilizer, seeds, pesticides and machinery equipments, in Libya. A distribution technique is used to analyze the relationship based on three possible responses from the farmers: very important; important; not important. The agricultural infrastructure assessed is road transportation, communication and information services, processing infrastructure, irrigation and public access to water, agricultural research and extension services, credit and financial institutions and markets. For the purpose of explanation, only a valid percentage is used for this study. The figures for the missing respondents are clarified in the following tables.

### 5.10.1 Road Transportation and Chemical Fertilizer Usage

Sixty-four percent of farmers indicate that road transportation is very important in their use of chemical fertilizers, and another 31% indicate that road transportation is important. Only 5% indicate that road transportation is not important. Although the majority of farmers are aware of the importance of roads in chemical fertilizers usage, the 5% of farmers that indicated that road transportation is not important are situated some distance from any roads.

### 5.10.2 Road Transportation and Manure Fertilizer Usage

Nearly half of respondents (46%) indicate that the availability of road transportation system is important for their usage of manure fertilizer and a further 41% indicate that roads transportation is very important for their usage of manure fertilizer. Only 12% indicate that the availability of the road transportation system is not important for their usage of manure fertilizer. The result shows that most of the farmers are familiar about the importance of roads in the availability of manure fertilizer.

### 5.10.3 Road Transportation and Improved Seed Usage

Forty -six percent of respondents say that road transportation systems are important to their usage of improved seeds and a further 45% indicate that the availability of road transportation system is very important in this case. Only 8% indicate that the availability of road transportation system is not important for their usage of improved seeds. The result shows that usage road was important for the availability of seeds in agricultural regions.

### 5.10.4 Road Transportation and Pesticides Usage

Fifty-six percent of the respondents point out that the road transportation infrastructure is very important while 38% of the respondents indicate that the availability of road transportation system is important for their usage of pesticides. Only 5% of the respondents indicate that the availability of road transportation system is not important for their usage pesticides. The result shows that the use of pesticides is related to the availability of roads in Libya.

### 5.10.5 Road Transportation and Machinery Usage

Sixty-seven percent of the respondents state that road transportation systems are very important, and a further 30% indicate that the availability of road transportation system was important for their usage of machinery. Only 3% of the respondents indicate that the availability of road transportation system was not important for their usage of machinery. The result indicates that of the use of machinery is related to the availability of roads. Table 5.17 summarises the importance of current roads in using agricultural inputs.

**Table 5.17 Current Roads Infrastructure and the Use of Agricultural Inputs of Respondents**

| Infrastructure | Level of Current Roads Infrastructure and the Use of Agricultural Inputs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | VERY IMPORTANT | | IMPORTANT | | NOT IMPORTANT | | | | |
| | No of Respondents | % | No of Respondents | % | No of Respondents | | of 277 | total no of non respondents out of 277 | % no of non respondents |
| Roads And Chemical Fertilizer Usage | 166 | 64.3 | 79 | 30.6 | 13 | 5 | 258 | 19 | 7 |
| Roads And Manure Fertilizer Usage | 107 | 41.3 | 120 | 46.3 | 32 | 12.4 | 259 | 18 | 6.5 |
| Roads And Seed Usage | 116 | 45.3 | 119 | 46.5 | 21 | 8 | 256 | 21 | 7.6 |
| Roads And Pesticides Usage | 141 | 56.4 | 96 | 38.4 | 13 | 5.2 | 250 | 27 | 10 |
| Roads And Machinery Equipments Usage | 173 | 67.3 | 76 | 29.6 | 8 | 3 | 257 | 20 | 7 |

Source: Derived from Survey Data, 2008; N=277

### 5.10.6 Communication and Information Services and Chemical Fertilizer Usage

Nearly half of farmers (45%) consider that availability of communication services is important in relation to the use of chemical fertilizers, while a further 32% think that communication services are very important. However, 22% indicate that communication services are not important in relation to the use of chemical fertilizers. The result indicates that the availability of communication infrastructure is enables the farmers to use chemical fertilizers.

### 5.10.7 Communication and Information Services and Manure Fertilizer Usage

Around half the respondents (44%) indicate that communication services are not important in relation to their use of manure fertilizer. However, 40% indicate that communication services are important for their use of manure fertilizer, while a further 16% indicate that communication services are very important for their use of manure fertilizer. The result indicates that there is a relationship between communication infrastructure and the use of manure fertilizers.

### 5.10.8 Communication and Information and Improved Seed Usage

Fifty-one percent of farmers indicate that communication and information service is important in relation to their use of improved seeds and a further 25% consider it very important. However, the same proportion, 25%, indicates that communication services are not important to their use of improved seeds. The result indicates that the availability of communication infrastructure is important in enabling farmers in the study to improve their seed usage.

### 5.10.9 Communication and Information Services and Pesticides Usage

Nearly half the respondents (45%) indicate that communication and information services are important to their usage of pesticides, while a further 34% indicate that communication services are very important to their usage of pesticides. However, 21% of respondents indicate that communication services were not important to their usage of pesticides. The finding result indicates a strong relationship between communication infrastructure and the use of pesticides.

### 5.10.10 Communication and Information Services and Machinery Usage

Forty-four percent of respondents stated that the availability of communication and information services is very important to machinery usage and a further 40% consider that the availability of communication and information services is important to machinery usage. However, 16% indicate that the availability of communication and information services is not important to machinery usage. Overall, the result indicates the importance of the availability of communication and information services to machinery usage. However, regarding the 16% of respondents who indicate that the availability of communication and information services is not important to machinery/equipment usage, this is probably because their farms are not located in the areas that are supported by the appropriate infrastructure. Table 5.18 summarises the importance of current communication and information services in using agricultural inputs.

**Table 5.18 Communication and Information Services and the Use of Agricultural Inputs of Respondents**

| Infrastructure | Level of Current Communication and Information Services Infrastructure and the Use of Agricultural Inputs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | VERY IMPORTANT | | IMPORTANT | | NOT IMPORTANT | | | | |
| | No of Respondents | % | No of Respondents | % | No of Respondents | | of 277 | total no of non respondents out of 277 | % no of non respondents |
| Communication & Information Services and Chemical Fertilizer Usage | 82 | 32.4 | 114 | 45 | 57 | 22.5 | 253 | 24 | 7 |
| Communication & Information Services and Manure Fertilizer Usage | 39 | 16 | 97 | 40 | 107 | 44 | 243 | 34 | 12 |
| Communication & Information and Seed Usage | 60 | 24.7 | 123 | 50.6 | 60 | 24.7 | 243 | 34 | 12 |
| Communication & Information Services and Pesticides Usage | 81 | 33.8 | 109 | 45.4 | 50 | 20.8 | 240 | 37 | 13 |
| Communication / Information Services and Machinery Equipment Usage | 109 | 44.5 | 97 | 39.6 | 39 | 15.9 | 245 | 32 | 11 |

Source: Derived from Survey Data, 2008; N=277

## 5.11 Importance of Processing Infrastructure and Use of Agricultural Inputs

### 5.11.2 Processing Infrastructure and Use of Chemical Fertilizers

Twenty-eight percent of farmers note that the availability of processing infrastructure is very important for the use of chemical fertilizer while 28% indicate that it is important. However, 44% indicate that processing infrastructure availability is not important for the use of chemical fertilizer. This result highlights the importance of fertilizer processing infrastructure such as chemical fertilizer manufacturing.

### 5.11.3 Processing Infrastructure and Use of Manure Fertilizer

Fifty-three percent of the respondents indicate that processing infrastructure availability is not important for the use of manure fertilizer. However, 30% indicate that processing infrastructure availability is important for the use of manure fertilizer, while a further 19% consider it to be very important. This finding shows that the importance of processing infrastructure for manure fertilizer usage is less than that for chemical fertilizer usage. However, this result also indicates that despite its importance, the availability of manure processing infrastructure is not sufficient to meet the demands of the farmers.

### 5.11.4 Processing Infrastructure and Use of Improved Seeds

Forty-five percent of respondents indicate that the processing infrastructure is not important for the usage of improved seeds. However, 32% of the respondents indicate that the processing infrastructure is important for the usage of improved seeds, while a further 22% consider that the processing infrastructure is very important. This result indicates that the use of seeds is related to the processing infrastructure for seeds.

### 5.11.5 Processing Infrastructure and Use of Pesticides

Forty-four percent of respondents indicate that the processing infrastructure is not important for the use of pesticides. However, 31% of the respondents consider that the processing infrastructure is important for the use of pesticides and a further 25% state that it is are very important. This result indicates the importance of the processing infrastructure for pesticide use.

### 5.11.6 Processing Infrastructure and Use of Machinery

Forty-five percent of respondents indicate that the processing infrastructure is not important for the use of machinery. However, 28% consider that the processing infrastructure is very important to the use of machinery equipment and a further 27% indicate that the processing infrastructure is important for the use of machinery. This result indicates the importance of the availability of the processing infrastructure for the use of the machinery equipment. Table 5.19 summarises the importance of the processing infrastructure in using agricultural inputs.

**Table 5.19 Processing Infrastructure and Use of Agricultural Inputs of Respondents**

| Infrastructure | Level of Current Communication and information Services Infrastructure and the Use of Agricultural Inputs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | VERY IMPORTANT | | IMPORTANT | | NOT IMPORTANT | | 277 | total no of non respondents out of 277 | % no of non respondents |
| | No of Respondents | % | No of Respondents | % | No of Respondents | | | | |
| Communication & Information Services and Chemical Fertilizer Usage | 82 | 32.4 | 114 | 45 | 57 | 22.5 | 253 | 24 | 7 |
| Communication & Information Services and Manure Fertilizer Usage | 39 | 16 | 97 | 40 | 107 | 44 | 243 | 34 | 12 |
| Communication & Information and Seed Usage | 60 | 24.7 | 123 | 50.6 | 60 | 24.7 | 243 | 34 | 12 |
| Communication & Information Services and Pesticides Usage | 81 | 33.8 | 109 | 45.4 | 50 | 20.8 | 240 | 37 | 13 |
| Communication/ Information Services and Machinery Equipment Usage | 109 | 44.5 | 97 | 39.6 | 39 | 15.9 | 245 | 32 | 11 |

Source: Derived from Survey Data, 2008; N=277

## 5.12 Importance of Irrigation and Public Access to Water and Use of Agricultural Inputs

### 5.12.1 Irrigation and Public Access to Water and Use of Chemical Fertilizers

Sixty-three percent of respondents indicate that irrigation and public access to water is very important for the usage of chemical fertilizers and a further 24% of the respondents consider that it is important for the usage of chemical fertilizers. Only 13% indicate the relationship is not important. This result indicates a very high degree of awareness of the importance of the availability of water in relation to the use of chemical fertilizers.

### 5.12.2 Irrigation and Public Access to Water and Use of Manure Fertilizer

Fifty-eight percent of respondents are of the view that irrigation and public access to water is very important for the use manure fertilizer, while 27% indicate that it is important for the use of manure fertilizer. Only 15% consider that irrigation and public access to water is not important for the usage of manure fertilizer. This finding shows a high degree of awareness of the importance of the availability of water for the utilization of manure fertilizer.

### 5.12.3 Irrigation and Public Access to Water and Use of Pesticides

Fifty-five percent of respondents consider that irrigation and public access to water is very important for the use of pesticides a further 26% indicate that it is important. Only 19% think that irrigation and public access to water is not important for the usage of pesticides. The result shows a high degree of awareness of the importance of the availability of water for the utilization of pesticides.

### 5.12.4 Irrigation and Public Access to Water and Use of Machinery

Fifty-three percent of respondents indicate that irrigation and public access to water is very important for the use of machinery, while a further 32% consider the relationship is important. Only 14% think that irrigation and public access to water is not important for the use of machinery. The result shows that the majority of farmers in the research sample in the agricultural regions have a very high degree of awareness of the importance of the relationship between irrigation and public access to water and the use of machinery.

### 5.12.5 Irrigation and Public Access to Water and Use of Improved Seeds

Fifty-eight percent of respondents noted that irrigation and public access to water is very important for the use of improved seeds, while 27% indicate that it is important for the usage of improved seeds. Only 15% think that irrigation and public access to water is not important for the usage of improved seeds. This finding shows a high degree of awareness of the importance of the availability of water for the use of improved seeds. Table 5.20 summarises the importance of irrigation and public access to water in using agricultural inputs.

**Table 5.20 Irrigation and Public Access to Water and Use of Agricultural Inputs of Respondents**

| Infrastructure | Level of Current Irrigation Infrastructure and the Use of Agricultural Inputs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | VERY IMPORTANT | | IMPORTANT | | NOT IMPORTANT | | of 277 | total no of non respondents out of 277 | % no of non respondents |
| | No of Respondents | % | No of Respondents | % | No of Respondents | | | | |
| Irrigation and Chemical Fertilizer Usage | 153 | 63.2 | 57 | 23.6 | 32 | 13.2 | 242 | 35 | 13 |
| Irrigation and Manure Fertilizer Usage | 134 | 58 | 63 | 27.3 | 34 | 14.7 | 231 | 46 | 17 |
| Irrigation and Seed Usage | 134 | 58.3 | 62 | 27 | 34 | 14.8 | 230 | 47 | 17 |
| Irrigation and Pesticides Usage | 125 | 55.1 | 58 | 25.6 | 44 | 19.4 | 227 | 50 | 18 |
| Irrigation and Machinery Equipments Usage | 122 | 53.3 | 74 | 32.3 | 33 | 14.4 | 229 | 48 | 17 |

Source: Derived from Survey Data, 2008; N=277

## 5.13 Importance of Agricultural Research and Extension Services and Use of Agricultural Inputs

### 5.13.1 Agricultural Research and Extension Services and Use of Chemical Fertilizers

Thirty-eight percent of respondents note that agricultural research and extension services are very important for the use of chemical fertilizers while the same proportion indicate that it is important for the use of chemical fertilizers. Only 25% indicate that the relationship is not important. This finding indicates a high degree of awareness about the importance of agricultural research and extension services in training farmers to use chemical fertilizers effectively.

### 5.13.2 Agriculture Research and Extension Services and Use of Manure Fertilizer

Thirty-nine percent of the respondents are of the opinion that agricultural research and extension services are not important for the use of manure fertilizer. However, 35% indicate the relationship is important, while 27% think the relationship is very important. This finding shows a reasonable degree of awareness about the importance of agricultural research and extension services in training farmers how to use manure fertilizer.

### 5.13.3 Agricultural Research and Extension Services and Use of Improved Seeds

Forty-two percent of respondents indicate that agricultural research and extension services are important for the use of important seeds, while a further 32% think that they are very important for the use of improved seeds. However, 26% consider the relationship is not important. This result indicates a high degree of awareness about the importance of agricultural research and extension services in training farmers how to deal with improved seeds.

### 5.13.4 Agricultural Research and Extension Services and Use of Pesticides

Thirty-seven percent of respondents note that agricultural research and extension services are very important for the use of pesticides, while 36% indicate they are important for the use of pesticides. However, 26% say the relationship is not important. This result indicates a high degree of awareness about the importance of agricultural research and extension services in training farmers how to use pesticides effectively.

#### 5.13.5 Agricultural Research and Extension Services and Use of Machinery

Thirty-five percent of respondents consider agricultural research and extension services are important for the use machinery, while 32% indicate that they are very important for the use machinery and equipment. However, 33% consider that agricultural research and extension services are not important for the use machinery. This finding shows a degree of awareness about the importance of agricultural research and extension services in training farmers how to use agricultural machinery in an effective way. For example, the role of agricultural services in training farmers in ploughing plays an important role in the conservation of the quality of the soil. Ploughing is considered important as part of weed control strategies in organic systems (Bond & Grundy, 2001). Table 5.21 summarises the importance of agricultural research and extension services in using agricultural inputs.

Table 5.21 Agricultural Research and Extension Services and Use of Agricultural Inputs of Respondents

| Infrastructure | Level of Current Agricultural research and extension Services Infrastructure and the Use of Agricultural Inputs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | VERY IMPORTANT | | IMPORTANT | | NOT IMPORTANT | | | | |
| | No of Respondents | % | No of Respondents | % | No of Respondents | | out of 277 | total no of non respondents out of 277 | % no of non respondents |
| Agricultural Research and Extension Services and Use of Chemical Fertilizer | 89 | 37.6 | 89 | 37.6 | 59 | 24.9 | 237 | 40 | 16 |
| Agricultural Research and Extension Services and the Use of Manure Fertilizer | 59 | 26.6 | 77 | 34.7 | 86 | 38.7 | 222 | 55 | 20 |
| Agricultural Research And Extension Services And Use Of Seeds | 70 | 31.8 | 92 | 41.8 | 58 | 26.4 | 220 | 57 | 20 |
| Agricultural Research and Extension Services and Use of Pesticides | 84 | 37.3 | 82 | 36.4 | 59 | 26.2 | 225 | 52 | 19 |
| Agricultural Research and Extension Services and Use of Machinery and Equipments | 71 | 31.7 | 79 | 35.3 | 74 | 33 | 224 | 53 | 19 |

Source: Derived from Survey Data, 2008; N=277

## 5.14 Importance of Credit and Financial Infrastructure and Use of Agricultural Inputs

### 5.14.1 Credit and Financial Infrastructure and Use of Chemical Fertilizers

Forty percent of respondents indicate that credit and financial institutions are important to chemical fertilizer usage and another 38% consider that they are very important. However, 21% indicate the relationship is not important. This result shows a high degree of awareness of the role and the importance of financial institutions in providing capital to farmers to buy chemical fertilizers.

### 5.14.2 Credit and Financial Institutions and Use of Manure Fertilizer

Forty-three percent of respondents are of the view that credit and financial institutions are not important to the use of manure fertiliser. However, 25% of respondents note that credit and financial institutions are very important to the use of manure fertiliser and a further 32% indicate that they are important to the use of manure fertiliser. This finding indicates a degree of awareness of the role and the importance of financial institutions in lending to farmers to buy manure fertilizer.

### 5.14.3 Credit and Financial Institutions and Use of Pesticides

Thirty-nine percent of respondents say credit and financial institutions are important for the use pesticides and a further 36% indicate that they are very important for the use pesticides. However, 25% think that credit and financial institutions are not important for the use of pesticides. This finding indicates a high degree of awareness of the role and the importance of financial institutions in lending to farmers to buy pesticides.

### 5.14.4 Credit and Financial Institution and Use of Machinery

Fifty-six percent of respondents note that credit and financial institutions are very important for the use of machinery, while a further 26% indicate that they are important for the use of machinery. Only 18% of respondents consider that credit and financial institutions are not important for the use of machinery. This finding indicates a high degree of awareness of the role and the importance of financial institutions in lending to farmers to buy machinery.

### 5.14.5 Credit and Financial Institutions and Use of Improved Seeds

Forty-four percent of respondents indicate that credit and financial institutions are important in the use of improved seeds, while 30% said they are very important. However, 26% consider that credit and financial institutions are not important in the use of improved seeds. This finding indicates a high degree of awareness of the role and the importance of financial institutions in lending farmers to buy seeds. Table 5.22 summarises the importance of credit and financial institutions in the use of agricultural inputs.

**Table 5.22 Credit and Financial Infrastructure and Use of Agricultural Inputs of Respondents**

| Infrastructure | Level of Current Credit and Financial Institution Infrastructure and the Use of Agricultural Inputs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | VERY IMPORTANT | | IMPORTANT | | NOT IMPORTANT | | out of 277 | Total no of non respondents out of 277 | % no of non respondents |
| | No of Respondents | % | No of Respondents | % | No of Respondents | | | | |
| Credit and Financial Institution and Chemical Fertilizer Usage | 93 | 38.6 | 98 | 40.3 | 52 | 21.4 | 243 | 34 | 12 |
| Credit and Financial Institution and Manure Fertilizer Usage | 57 | 25.3 | 72 | 32 | 96 | 42.7 | 225 | 52 | 19 |
| Credit and Financial Institution and Seed Usage | 66 | 29.6 | 98 | 43.9 | 59 | 26.5 | 223 | 54 | 19.5 |
| Credit and Financial Institution and Pesticides Usage | 80 | 35.9 | 87 | 39 | 56 | 25 | 223 | 54 | 19.5 |
| Credit and Financial Institution and Machinery Equipment Usage | 129 | 56.3 | 59 | 25.8 | 41 | 17.9 | 229 | 48 | 17 |

Source: Derived from Survey Data, 2008; N=277

## 5.15 Importance of Market Infrastructure and Use of Agricultural Inputs

### 5.15.1 Market Infrastructure and Use of Chemical Fertilizers

Sixty-two percent of respondents indicate that markets are very important for chemical fertilizer usage, while a further 32% consider that markets are important for chemical fertilizer usage. Only 5% think that markets are not important for chemical fertilizer usage. This result shows a very high degree of awareness of the role and the importance of markets in the availability of chemical fertilizers.

### 5.15.2 Markets Infrastructure and Use of Manure Fertilizer

Forty-six percent of respondents are of the view that markets are very important for the use of manure fertiliser, while a further 35% indicate they are important.

However, 18% indicate that markets are not important for manure fertilizer usage. This finding indicates a degree of awareness of the role and the importance of markets in the availability of manure fertilizer.

#### 5.15.3 Markets Infrastructure and Use of Pesticides

Fifty-six percent of respondents say markets are very important for the use pesticides, while a further 39% indicate it is important. Only 5% consider that markets are not important for the use of pesticides. This finding indicates a very high degree of awareness of the role and the importance of markets in providing pesticides.

#### 5.15.4 Markets Infrastructure and Use of Machinery

Sixty percent of respondents noted that markets are very important for the use of machinery, while a further 34% indicate that they are important for the use of machinery. Only 6% consider that they are not important. This finding indicates a very high degree of awareness of the role and the importance of markets in providing machinery.

#### 5.15.5 Markets Infrastructure and Use of Improved Seeds

Fifty-two percent of respondents indicated that markets are very important in the use of improved seeds, while a further 43% say they are important. Only 5% think that markets are not important in the use of improved seeds. This finding indicates a very high degree of awareness of the role and the importance of markets in the use of improved seeds. Table 5.23 summarises the importance of Markets infrastructure in using agricultural inputs.

**Table 5.23 Markets Infrastructure and Use of Agricultural Inputs of Respondents**

| Infrastructure | Level of Current Markets Infrastructure and the Use of Agricultural Inputs | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | VERY IMPORTANT | | IMPORTANT | | NOT IMPORTANT | | out of 277 | total no of non respondents out of 277 | % no of non respondents |
| | No of Respondents | % | No of Respondents | % | No of Respondents | | | | |
| Markets and Chemical Fertilizer Usage | 154 | 62.6 | 79 | 32.1 | 13 | 5.3 | 246 | 31 | 11 |
| Markets and Manure Fertilizer Usage | 106 | 45.9 | 82 | 35.5 | 42 | 18.2 | 230 | 47 | 17 |
| Markets and Seed Usage | 121 | 51.9 | 101 | 43.3 | 11 | 4.7 | 233 | 44 | 16 |
| Markets and Pesticides Usage | 132 | 56.4 | 91 | 38.9 | 11 | 4.7 | 234 | 43 | 15.5 |
| Markets and Machinery Equipment Usage | 140 | 60.1 | 80 | 34.3 | 13 | 5.6 | 233 | 44 | 16 |

Source: Derived from Survey Data, 2008; N=277

## 5.16 Infrastructure and Organic Farming Practices

This section analyzes to what extent the agricultural infrastructure availability enables farmers to implement organic agricultural practices and to prevent environmental problems. The aim is to assess the level of practice by farmers of organic farming practices. This assessment is about the relationship between agricultural infrastructure and organic farming practices and its impact on aspects such as conservation, maintenance of soil fertility, chemical fertilizer usage, manure fertilizer usage, crop rotation and biological control. A distribution technique is used to analyze the various relationships based on the three possible responses by farmers: yes; no; don't know. For the purpose of explanation, only the valid percentage is used for this study. The responses and missing data are clarified in Table 5.24, which summarises the importance of the current availability of infrastructure in enabling farmers to address organic farming practices.

### 5.16.1 Soil Fertility Farming Practices

Caring for and maintaining soil conditions are the most important actions in the defence against pests. The circulation of air inside the soil along with good drainage is considered to be good for biological activity in the soil. Good fertile soil facilitates crop growth in good condition, allowing crops to compete with weeds.

Fifty-eight percent of farmers said that the available infrastructure enables them to care for the long-term fertility of the soil, while 25% indicate they do not know the effect of the available infrastructure on soil fertility and 17% think the available infrastructure has no effect on soil fertility. This result shows that more than half of the respondents are able to use the available infrastructure to care for soil fertility. However, the 17% of respondents who are not able to do this may be located in an area with fewer infrastructures. Nevertheless, these farmers should be developing their knowledge about soil fertility issues.

### 5.16.2 Chemical Fertilizer Usage

Forty-four percent of farmers indicate that the available infrastructure enables them to use chemical fertilizers, while 42% consider it has no effect on the use of chemical fertilizers and 15% do not know the effect of the available infrastructure on chemical fertilizer usage. The high level of respondents who consider there is no relationship could be located in areas with less development in infrastructure but it could also be due to awareness about the dangers of using chemical fertilizers. This awareness could make these farmers a target for conversion to organic farming. Escobar and Hue (2007) state that the absence of synthetic fertilizers and pesticides in organic farming necessitates inputs from manure in addition to crop selection or irrigation.

### 5.16.3 Manure Fertilizer Usage

Organic manure is used to provide essential nutrients to crops. However, if not properly managed, organic manure may also promote problems such as losses by de-nitrification (Smith & Chambers, 1993; Escobar & Hue, 2007) and ammonia volatilization (Holding, 1982 cited in Escobar & Hue, 2007). Therefore, organic manure is important in organic farming in order to avoid contamination of soil and water by chemicals and to conserve the micro-organisms in the soil.

Sixty-five percent of farmers indicate that the availability of infrastructure enables them to use manure fertilizer, while 23% think it does not and 12% do not know the effect of availability of infrastructure on the use of manure fertilizer. The finding is positive for the conversion to organic farming as these farmers already use a vital component of organic farming. Regarding the small percentages who do not know the effect of infrastructure on the usage of manure fertilizer, this may be because their farms are located in areas with less access to infrastructure.

### 5.16.4 Crop Rotation

Escobar and Hue (2007) define crop rotation as alternating crops in time (rotations) or space (strip-cropping and inter-cropping). Crop rotation is an important tool for controlling pests, and also for maintaining soil fertility. Therefore, it is considered one of the most important methods for the protection agricultural crops from various diseases. The rotation interrupts the life cycle of the pathogens and results in the reduction of pest population.

Fifty-eight percent of farmers are of the view that the available infrastructure enables them to follow crop rotation, 17% indicate it does not and 25% do not know the effect of availability of infrastructure on crop rotation. Those farmers who do not consider there to be a relationship between infrastructure and crop rotation should be targeted to increase their awareness about how to increase soil fertility.

### 5.16.5 Biological Control

Biological control is defined as "the action of parasites, predators or pathogens in maintaining another organism's population density at a lower average than would occur in their absence" (De Bach, 1964). Therefore, using biological control methods helps to control disease in organic farming. This is achieved by using insects and bio-control agents which destroy the insect pests but do not harm the crop.

Thirty-nine percent of farmers indicate that the available infrastructure gives them the choice to use biological controls, while 32% do not know how the use biological controls could help them, and 29% consider that the availability of infrastructure does not give them the choice to use biological controls. The result indicates a lack of awareness about biological control techniques rather than the failure to establish organic farming in Libya. However, those farmers who know about these techniques say they are not used on their farms to combat and control disease.

**Table 5.24 Importance of the Current Availability of Infrastructure in Enabling Farmers to Address Organic Farming Practice of Respondents**

| FARMING PRACTICES | Yes | | NO | | DON'T KNOW | | Total no of respondents out of 277 | total no of non respondents out of 277 | % no of non respondents |
|---|---|---|---|---|---|---|---|---|---|
| | No of Respondents | % | No of Respondents | % | No of Respondents | | | | |
| SOIL FERTILITY | 156 | 58.4 | 45 | 16.9 | 66 | 24.7 | 267 | 10 | 4 |
| CHEMICAL FERTILIZER USAGE | 115 | 43.6 | 110 | 41.7 | 39 | 14.8 | 264 | 13 | 5 |
| MANURE FERTILIZER USAGE | 172 | 65.4 | 60 | 22.8 | 31 | 11.8 | 263 | 14 | 5 |
| CROP ROTATION | 151 | 58.1 | 44 | 16.9 | 65 | 25.0 | 260 | 17 | 6 |
| BIOLOGICAL CONTROL | 97 | 38.6 | 73 | 29.1 | 81 | 32.3 | 251 | 26 | 9 |

Source: Derived from Survey Data, 2008; N=277

## 5.17 Agricultural Infrastructure and Farmers' Decisions

This section analyzes the relationship between the available agricultural infrastructure and farmers' decisions in relation to aspects such as extending land holding, crop production, agricultural practices, new technology, new agricultural methods and profit. A distribution technique is used to analyze the relationship agricultural infrastructure and the farmers' decisions based on four possible responses: extremely important; very important; important; not at all important. This analysis is important for understanding how infrastructure affects important issues in relation to organic farming principles and concepts. For the purpose of explanation, only the valid percentage is used for this study. The responses and the missing data are detailed in Table 5.25, which summarises the importance of the current availability of Agricultural Infrastructure and farmers' decision making.

### 5.17.1 Agri-land holding

More than half (51%) of the farmers indicate that the current infrastructure is extremely important to their decisions to extend their area of agri-land holdings. Furthermore, 29% consider it is very important and 15% think it is important. Only 5% indicate it is not at all important. This result indicates that the available agricultural infrastructure is vital in farmers' decisions to extend their land for agricultural activities. This implies that farmers' decisions to extend their agricultural activities are, in part, determined by the level of the availability of agricultural infrastructure. The small number that sees no relationship between the two variables could be located in areas where the infrastructure is not developed or there is no provision of infrastructure.

### 5.17.2 Crop Production

Forty percent of farmers indicate that current infrastructure is very important to their decision to produce a greater variety of crops, while 47% and 16% consider that it is extremely important and important respectively. Only 7% think it is not at all important. The finding result indicates that farmers' decisions to produce a greater variety of crops are strongly affected by the availability of infrastructure.

### 5.17.3 Agriculture Practices

Thirty-eight percent of farmers are of the opinion that the current infrastructure is extremely important to their decisions to undertake necessary agricultural practices. 31% and 23% indicate it is very important and important respectively. Only 7% consider it is not at all important. This finding shows that availability of agricultural infrastructure is important in undertaking agricultural practices. This result highlights the importance of agricultural infrastructure in implementing agricultural practices: thus the practice of fertilization depends on the manufacture of fertilizer, its availability through the markets, funding from agricultural, transportation by roads, and water via irrigation systems.

### 5.17.4 New Technology

The development and growth of organic farming requires further input cost reductions in order to increase profits, and also to lower consumer prices and therefore increase demand. One method of achieving this could be through the introduction of new technology (Bria et.al., 2005). The availability of infrastructure determines to what extent farmers can introduce new technology. The result shows that 45% of farmers indicate that current infrastructure is extremely important in relation to their decisions to introduce new technology. 28% consider it is very important and another 28% think it is important with only 8% indicating it is not at all important. The findings highlight that farmers' decisions to introduce new technology are determined in part by the availability of infrastructure. This result suggests that the introduction of new technology should be related to the level of and the type infrastructure in place.

### 5.17.5 New Agricultural Methods

Forty-three percent of the farmers indicate that the current infrastructure is extremely important for their decision to introduce new agricultural methods. 24% and 21% indicate it is very important and important respectively. Only 12% said it is not at all important. This finding shows that availability of agricultural infrastructure is important for introducing agricultural methods. This result implies that effectiveness of agricultural methods is determined by the level of availability of agricultural infrastructure.

### 5.17.6 Profit Levels

Sixty-six percent of farmers indicated that the current infrastructure is extremely important to their decision to generate higher profits. 20% and 9% say it is very important or important respectively, while only 5% consider that it is not at all important. This result indicates that the available agricultural infrastructure is critical in farmers' decisions to achieve higher profits. The small proportion of farmers who do not believe in the relationship may be located in undeveloped areas.

**Table 5.25 Importance of Agricultural Infrastructure and Farmers' Decision Making of Respondents**

| DECISIONS | AGRICULTURAL INFRASTRUCTURE AND FARMERS DECISION MAKING | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | EXTREMELY IMPORTANT | | VERY IMPORTANT | | IMPORTANT | | NOT AT ALL IMPORTANT | | Total no of respondents out of 277 | total no of non respondents out of 277 | % no of non respondents |
| | No of Respondents | % | No of Respondents | % | No of Respondents | % | No of Respondents | % | | | |
| Agri-Land Holding | 137 | 50.6 | 79 | 29.2 | 42 | 15.5 | 13 | 4.8 | 271 | 6 | 2 |
| Crop Production | 98 | 36.6 | 107 | 39.9 | 43 | 16 | 20 | 7.5 | 268 | 9 | 3 |
| Agriculture Practices | 102 | 38.5 | 82 | 30.9 | 62 | 23.4 | 19 | 7.2 | 265 | 12 | 4 |
| New Technology | 120 | 45.3 | 75 | 28.3 | 48 | 18.1 | 22 | 8.3 | 265 | 12 | 4 |
| New Agricultural Methods | 113 | 42.8 | 64 | 24.2 | 55 | 20.8 | 32 | 12.1 | 264 | 13 | 5 |
| Profit Levels | 174 | 66.2 | 52 | 19.8 | 23 | 8.7 | 14 | 5.3 | 263 | 14 | 5 |

Source: Derived from Survey Data, 2008; N=277

# CHAPTER SIX

## QUALITATIVE DATA ANALYSIS

### 6.0 Introduction

This chapter presents the analysis of interviews conducted with ten officials from the Ministry of Agriculture, the various Agricultural Organizations, the Ministry of Inspection and Observation, and retired agriculture experts. These interviews were conducted to explore the importance of agricultural infrastructure availability and accessibility to the development of organic farming in Libya from the perspective of government officials and non-government experts. The analysis, which is carried out thematically, is presented in nine sections; role of infrastructure in agricultural development: quality, capacity and efficiency of agricultural infrastructure: satisfaction with standards and effectiveness of agricultural infrastructure: introduction of new technologies: strengths and weaknesses in the agricultural infrastructure: prospects for the modernization of agricultural infrastructure: financing of agricultural infrastructure; role of agricultural banks; and development of organic farming.

### 6.1 Analysis

#### 6.1.1 Role of Infrastructure in Agricultural Development

Infrastructure has an important role in the development of agriculture in Libya. It was noted that electricity, roads, and communication facilities have had a significant impact in the expansion of agricultural activities in the country and has contributed to increase in agricultural production. Interviewee A confirms "Agricultural infrastructure in Libya has a major role in making a significant shift in conventional farming systems to organic farming practices."

Since the 1970s, Libya has attempted to diversify its dependency away from the oil sector, through developing other sectors, including agriculture, since Libya has more than two million hectares of land suitable for agriculture. The state allocated millions of dinars to establish the infrastructure necessary for the development of the economy and the agriculture sector in particular. This resulted in an improved road network, new irrigation systems and the digging of water wells, the establishment of agricultural banking facilities and the development of industries related to the agricultural sector, such as food production.

The provision of this infrastructure has helped greatly in making real changes to the economy. In particular, agricultural production has increased, which in turn has resulted in increased agricultural exports to regional and international markets. Furthermore, a large number of people are now employed or work for themselves in agricultural projects and related industries. As Interviewee A stated, "General infrastructure plays a major role in the development and growth of the agricultural sector in Libya." In relation to the level of employment Interview D argues, "Improved agricultural infrastructure has led to a substantial increase in employment in the agricultural sector." Not only have the number of people involved in the sector but also the quality of those working has been improved with the help of the improved infrastructure.

The improved road system since the 1970s, has significantly contributed to the development and growth of the agricultural sector. The network has resulted in the introduction of modern agricultural machinery in most farming areas in Libya and contributed to the supply and use of improved seeds and fertilizers, as well as better access to markets. Thus, the improved road network between the south and the north of the country has contributed to increased cereal production in the south through the provision of newly claimed agricultural lands, the introduction of farming machinery in areas deep in the desert, the distribution and use of various production tools such as seeds, fertilizers and insecticides. As Interviewee E stated, "Our agricultural produce could neither have access to the markets or storage". Interviewee B argues that without such roads, we could not have transported the production of these projects to the consumption centres, mostly in the north of Libya, where the population is concentrated.

Furthermore, the introduction of new technologies in agricultural areas, such as Fezzan, contributed to the better utilization of natural resources such as water, which led to an increase in agricultural productivity. This is supported by the comments from Interviewee C: "Generally, the availability of infrastructure plays a significant role in the development of the agricultural sector and contributes to food production and security which are embodied in current government policies."

Another area in which the agricultural infrastructure has improved is finance. The introduction of the Agricultural Bank has greatly contributed to the development and growth of the agricultural sector in the Libya. The bank's direct involvement with farmers has had a significant impact on the development of the agricultural sector, through supporting investment and capital flows of farms. Thus, Interviewee F states: "Banks play a major role in developing the agricultural systems and the growth of farming areas." It was noted that agricultural infrastructure is the major factor in encouraging people to establish farms and various other agricultural projects. Interviewee F again: "The Bank contributed in financing and the establishment of various projects totalling 7,377 project, with a total value of LD507 million. The number of those who have directly benefited from these projects total 9,131 people."

However, the improvements in agricultural infrastructure have not only boosted productivity, but also investment in the sector. Interviewee D confirms this: "The availability of the infrastructure in itself has encouraged the tendency for investment in the agricultural sector". The improvements in output and investment have also been assisted a reduction in waste in the production of agricultural produce because of better access to markets, storage and processing facilities. All this has helped to improve profitability in the sector.

Furthermore, the improvements in agricultural infrastructure have helped with diversification of output. Thus new crops such as bananas, apples, and various cereals, have been introduced. Animal husbandry has also improved productivity, in particular for livestock, poultry and dairy production.

The overall improvements are recognised by Interviewee D: “Generally, the role played by agricultural infrastructure may be summarized as providing for the food requirements, training of technical cadres in the agricultural sector, education of farmers, and increase in the diversity of products and the introduction of new technologies and new agricultural systems. These would lead to the general increase of agricultural produce.” Interviewee E also notes that agricultural infrastructure is the basis for all development in the agricultural sector.

### 6.1.2 Quality, Capacity and Efficiency of Agricultural Infrastructure

The agricultural infrastructure available in the Libya has improved since the 1960s, when there was generally no or little infrastructure provision. Nevertheless, the present infrastructure requires further maintenance, improvement and modernization. In particular, more effort is needed to develop the role of agricultural research, training centres, Agricultural Banks, irrigation systems and the modernization of poultry production units. The agricultural infrastructure available in the Libya can be classified into three categories: i) highly satisfactory, ii) satisfactory and iii) unsatisfactory, with regard to quality. Communications, mobile phone systems are classified as highly satisfactory; roads as satisfactory; and food production facilities as unsatisfactory.

Thus, the success of the agricultural sector is not just dependent on the provision of the necessary infrastructure but is also dependent on factors such the nature, funding and policies that determine the quality of infrastructure. As Interviewee F highlights, there is also a great deal of inefficient and poor productivity in the agricultural sector as a result of administrative measures and procedures. Interviewee H raised a valid point when he argued that the efficiency of infrastructure is determined by the quantity and quality of production, the levels of profitability, manpower employed and the agricultural areas under production and any increase or reduction in production comes as a result of the conditions of the agricultural infrastructure.

In relation to the types of infrastructure, the establishment of research centres has facilitated the research process.

The maintenance of irrigation systems is needed to prevent substantial loss of water. At present, there is a clear deficiency with regards to water systems, water wells and their maintenance. Most of the irrigation systems are quite old and cause serious loss of water resources. Modernization of irrigations systems would lead to much better production, with regards to quantity and quality.

As previously discussed, roads have contributed significantly to the development of Libyan agriculture. However, although there has been some improvement in the road networks, these need to be expanded, upgraded and modernized. As Interviewee A argues, "A number of agricultural roads are dilapidated and this affects the cost of transportation. It also undermines the longevity of machines and equipment that are transported over such roads. Furthermore, a large quantity of production is lost while being transported."

The market is another area in which improvements require to be made; at present it is still weak for agricultural products due to poor planning systems. As Interviewee A expanded: "A large number of markets have emerged without planning or organization and some of these markets have disappeared overnight. That affects the nature of production, as the farmer is not encouraged to produce for the market, in view of the instability of the market."

### 6.1.3 Satisfaction with Standards and Effectiveness of Agricultural Infrastructure

Total satisfaction of farmers as to the accessibility, standards and effectiveness of agricultural infrastructure is difficult to achieve, the state in Libya has to undertake its development and improvement. Satisfaction with infrastructure provision varies between geographical areas and between types of infrastructure: for example, there is general satisfaction by farmers in respect of phone services, both mobile and land lines. Satisfaction levels are closely related to the availability of the infrastructure. Thus where farms have access to roads, communications, agricultural service centres, agricultural societies, factories and markets, farmers are generally more happy and satisfied. However, on farms where there is little infrastructure and where the services are lacking farmers are not satisfied. Thus, Interviewee I concludes that a good number of agricultural areas are in quite remote areas, where there are no adequate services and no roads, no markets, no industries and no Bank branches and therefore farmers are not satisfied.

One area of concern raised by farmers is access to credit. Ways of addressing this issue could be through raising the ceiling of agriculture loans, introducing longer repayment terms and reducing interest rates. For example, Interviewee G noted that in the period 2006 to 2009, only 30% of farmers' demands for support were met. Thus, the loans offered are not always adequate to meet the needs of the farmers. Furthermore, Interviewee H states: "Loans are sometime denied or come very late, or simply not there, even though the Bank has actual presence with branches at all areas of the Libya."

Another area in which farmers are not very satisfied in relation to the standards and quality of the agricultural infrastructure is the shortage of production requirements, for inputs such as fertilizers, insecticides and seeds. Furthermore, even if they are available, then their prices are very high.

There is also the question of the agricultural societies which are weak or collapsing. The services provided by these societies in the area of guidance to farmers are vital in enhancing satisfaction.

One of the challenges facing farmers is access to markets. The agricultural processing industries are inefficient and cannot utilise the output of the sector. In many cases surplus agricultural production go waste as there are no storage facilities. A typical example is the case of dates. Date factories are so few and their capacity is limited. This is summed up by Interviewee H: "I believe that farmers are unsatisfied with the lack of food industries to handle the production surplus."

There is also a noticeable lack of satisfaction in respect of water and irrigation systems. There are wide fluctuations in rainfall levels and the lack of dams and proper irrigation systems contribute to the level of dissatisfaction expressed by farmers. The present irrigation networks are not properly maintained and many water wells are collapsing. The situation is made worse by the poor quality in the supply of electricity which is not constant. This damages the electric water pumps which are costly to maintain.

A further area of difficulty is the lack of information and guidance centres. Currently complaints are received from farmers in relation to the agricultural infrastructure through the Secretariat of Agriculture in the various '*Shabiyas*' (districts), as well as through the General Peoples Committee for Agriculture. However, there is general dissatisfaction about the lack of a clear mechanism within the Secretariat of Agriculture at present to tackle complaints. Interviewee B argues: "The sector has no specialised mechanism to tackle complaints regarding agricultural infrastructure." Though these secretariats are highly important, they are more effective when collaborating with other bodies such as the Farmers' Union and competent authorities than they are at handling complaints.

In order to start to improve the situation, regular field surveys to detect and offer solutions to problems at an early should be implemented in order to improve farmer's satisfaction. Furthermore, improved relationships between farmers and the Secretariat of Agriculture and regular contacts between all concerned parties, along with the introduction and use modern technology can also help to improve the situation. However, farmers have to be educated and trained to use modern technology.

There are a number of indicators which can be used to measure farmers level of satisfaction with agricultural infrastructure. The most important of these are when agricultural operations facilities are provided on schedule. Table 6.1 highlights the factors that can be used to measure farmers' satisfaction.

**Table 6.1 Measurement of Farmers' Satisfaction from Interviews**

| | |
|---|---|
| 1 | Availability of agricultural equipment and inputs |
| 2 | Reduction in complaints by farmers |
| 3 | Increase in the areas used for farming |
| 4 | Increased levels of productivity and profitability |
| 5 | Increased field visits and dissemination of field studies and surveys |

Source: Derived from Interview Data, 2008; N=277

### 6.2.4 Introduction of New Technologies

The introduction of modern technologies in agriculture requires a certain level of agricultural infrastructure. For example; when cereal production projects were designed in the Sahara Desert, focal irrigation was designed to match the environment. This system required the availability of electric energy, which is vital for running of the irrigation system. A further example of the requirement for infrastructure to support new technologies is in establishing new modern livestock and dairy projects. The existence of slaughter houses and refrigeration stores was vital for the success of these projects.

The interviewees acknowledge the importance of proper planning before the introduction of modern technologies in the agricultural sector in order that they may contribute to improved productivity.

### 6.2.5 Strengths and Weaknesses in the Agricultural Infrastructure

The strengths and weaknesses in the agricultural infrastructure in Libya were derived from the interview and the farmers' questionnaire. These can be summarized as:

**Strengths**

1- Spread of infrastructure such as electric supply, roads and communication systems
2- Availability of irrigation systems
3- Increased awareness of markets
4- Availability of markets
5- Construction of the Great Man-made River

**Weaknesses**

1- Absence of modernization and lack of improvements
2- Inefficiency of some agricultural bodies and institutions
3- Absence of processing facilities
4- Absence of infrastructure for the production of seeds
5- Lack of maintenance for the infrastructure

### 6.2.6 Prospects for the Modernization of Agricultural Infrastructure

There are great prospects for the modernisation of agricultural infrastructure in Libya. However, to be successful, this requires research on the present impact of the infrastructure on increasing productivity, increasing the areas available for farming, job opportunities and increasing animal production. Such studies should cover among other aspects quality and accessibility of current infrastructure.

Interviewee B believes that it is vital to develop agricultural current service centres, of which agricultural societies are a part, and that Agricultural Bank should offer more loans, especially long-term ones. There are also prospects for improving markets to handle increases in agricultural production.

The prospects for the modernisation of agricultural infrastructure in Libya could be achieved through the development of appropriate policies that will consider present agricultural infrastructure and the need to increase the agricultural sector contribution in the general national economic growth. Such policies can be implemented through agricultural agencies at local and national levels.

The prospects for the modernisation of agricultural infrastructure in Libya will be enhanced if there is increase in funding by the state to improve existing infrastructure with the introduction of modern technologies, especially in the area of irrigation and modern systems that are tailored to the specific natural conditions. Again agricultural services such as Agricultural Bank, markets, standardization units and processing factories need to be developed to increase the prospects of modernising agriculture in Libya.

Modernisation prospects will be enhanced if existing roads are improved and extended to all areas of agricultural potential, linking the areas with the markets. Also Agricultural service centres should have modern technological systems to train farmers and processing factories should be established.

Any future vision for developing the agricultural sector should take into consideration the following:-

- Improving the present agricultural infrastructure.
- The development of natural resources generally.
- The introduction of new development areas.

All these aspects are very important for the increase of production, by the increased use of modern technologies of agricultural production. This is vital to achieve national food security in the Libya. There has to be a sort of balance between agricultural investment and the requirements of food security.

In general, each category of agricultural and animal production has its own future vision. This applies to livestock, poultry, dairy and seeds. Water management has its own future vision as well.

### 6.2.7 Financing of Agricultural Infrastructure

There is a need for more funding in order to achieve the goals set in the sector. At present, Interviewee G summed up the issue of financing agricultural infrastructure by noting that "the level of financing for the agricultural infrastructure has not yet achieved the required level. In fact there is shortage of funding which may have negative effects of the development of the agriculture sector." The volume of finance for the agricultural infrastructure depends on the state budget for development. However, there is advocacy to seek other sources of financing.

The interviewees noted that studies are required to establish the financing requirements of farmers. In turn, the farmers believe that the agriculture infrastructure is in need of more funding to attain the general targets in the agricultural sector.

The researcher suggests that a larger share of financing should be directed to roads, particularly agricultural roads. In addition, as highlighted by Interviewee C: sectors such as marketing, standardization units and the development of modern processing /storage facilities should receive extra finance.

### 6.2.8 The Role of the Agricultural Banks

Although the agricultural banks are performing a significant role in the development of the agricultural sector, the respondents indicated that loans offered are still too small and the repayment period is quite short. Generally the level of financing is still very weak. The volume of financing does not allow the achievements of the goals set.

There is the view that the current policies of agricultural banks can not lead to the development of the agriculture sector. Although the banks are taking into consideration the proposals and plans laid down by the GPCA for Agriculture, they are not committed to abide by such proposals. The interviewees indicated that the agricultural banks are not fully committed to the plans and proposals made by the GPCA for Agriculture. It was acknowledged that while the banks operate with the policies and plans set down by the General People's Congress but their ability to fully implement these policies is questionable. The GPCA is required is to lay down policies that prioritise financial support for the agricultural sector. However, there needs to be a high degree of cooperation between the GPCA for Agriculture and the banks.

### 6.2.9 Development of Organic Farming

There should be a major incentive to shift to organic farming as Libya has the advantage of being close to the international markets in Europe, where there is a huge demand for organic produce. However, there are only limited plans for the development of organic farming in the country, although it has long been practised in Libya.

Despite these barriers, the interviewees believe that current conditions are suitable for organic farming. Interviewee C notes: "There are potentials for Libyan farmers to engage in organic farming, but the plans are not actively developed in that direction."

With the exception of one interviewee, who has sufficient knowledge about government plans for the development of organic farming, the other respondents lacked awareness of the plans to develop the sector. There are plans to shift to organic farming and some collaboration has been done with other countries which have experience in this area, including training farmers and conducting experiments within the past two years to test the feasibility of these plans.

## 6.3 Summary

The transformation from conventional farming to organic farming in Libya will depend on the availability and accessibility of agricultural infrastructure. This chapter presented qualitative research information relating to agricultural infrastructure (availability and accessibility) in Libya as reflected in expert opinion. This information is used in the discussion chapter to assess if the current agricultural infrastructure in Libya promotes or hinders the transformation to organic farming. In the overall evaluation the in-depth expert stakeholder opinions are compared to the quantitative data generated by the farmer questionnaires.

# CHAPTER SEVEN

## DISCUSSION

### 7.0 Introduction

The earlier sections of the thesis highlighted key aspects of the relationship between agricultural infrastructure availability and accessibility. Furthermore, the research investigated how these interactions can facilitate the potential transformation to organic farming in Libya. A mixed methods approach was used to collect data and the findings were triangulated to address the research aim of critically examining whether agricultural infrastructure facilitates the development of organic farming in Libya. The research revealed several important factors that impinge on infrastructure and agricultural development in Libya. This chapter focuses on those infrastructural factors that may affect transformation to organic farming in Libya. Thus the discussion focuses on the most important findings in terms of organic transformation, though factors of less direct importance are also identified. This chapter discusses the key findings of the primary research within the context of the relevant literature reviewed in Chapters 2 and 3. The structure of this chapter is based on the objectives of the research, namely:

1. To explore the current levels and provision of agricultural infrastructure in Libya;
2. To examine the effect of current infrastructure on farming practices; and
3. To evaluate the critical barriers that may influence the establishment of an organic farming system in Libya.

In order to achieve the objectives of the research, this chapter discusses how the successful development of organic farming in Libya depends on existing infrastructure, and it considers the following points:

1. The historical context of the farming culture of Libya in order to demonstrate the drivers for organic farming.
2. The Libyan Government's policies including planning issues and attitudes to the establishment of organic farming.
3. The characteristics of farmers and their farms and how they are influenced by the availability and accessibility of agricultural infrastructure.
4. The current levels and provision of farming infrastructure in Libya.
5. The type of infrastructure needed in order to establish organic farming in Libya.
6. The evaluation of the critical quantifying barriers and constraints that may influence the establishment of an organic farming system in Libya.

Therefore, the discussion of the above issues will help answer the research question "Does the successful development of organic farming in Libya depend on the adaptability of the existing infrastructure?"

The chapter is in four main sections. The first section provides an overview of the characteristics of Libyan farmers and their farms. The second section addresses the quantitative findings and issues arising from the analysis of data on availability and accessibility of agricultural infrastructure in Libya. The third section reviews the effect of infrastructure on farming practices in Libya. Lastly, the fourth section triangulates the findings of the quantitative data with the qualitative interview data to discuss critical barriers that might influence transformation to organic farming in Libya.

### 7.1 Overview of Libyan Farmers and their Farms

This section provides a broad overview of the characteristics of Libyan farmers and their farms in order to aid understanding of the context of the research. This is important in terms of the ability and indeed the potential willingness of farmers to embrace organic agriculture in Libya.

The age of farmers shapes agricultural practices. The majority (52%) of farmers in the sample are in the 52 to 72 year age band. This may mean that the majority of farmers are steeped in traditional farming practices and it may be difficult to get them to implement new organic farming systems. However, 17% of the farmers are aged between 30 and 40 years; therefore, in their quest to introduce organic farming in Libya, policy makers should target younger farmers, which in this study means those aged 30-40 years. Targeting this age group seems to be better, and is supported by the findings of Fasterding and Rixen (2006) and Trauger *et al.* (2008) of not targeting older farmers. This is because due to their age they might have physical difficulties that could prevent them from converting to organic farming, which is considered to be a labour intensive system.

Furthermore, studies by the Soil Association in the UK (2006), whilst not in a Libyan context, are still relevant. These reveal that on average, organic farmers are younger than are non-organic farmers. In addition, targeting younger farmers for conversion is also supported by the finding of Tress (2003) that in the county of Ribe in Denmark the percentage of farmers with a positive attitude towards conversion was highest among farmers less than 40 years old. Moreover, this is supported by Lockeretz (1995), who found that in Massachusetts, USA, organic farmers were younger than non-organic farmers.

This indicates that farmers' age is associated with their decision as to whether to convert to organic farming, when considering the risk of transformation to organic. Thus, age plays an important role in farmers' attitude to transformation to organic farming. Therefore, it would be good for stakeholders in Libya to target farmers aged between 30-51 years (46%) of Libyan farmers in relation to conversion to organic farming.

Further analysis shows that farmers in the Fazzan region are relatively younger compared those in the Algabal Al-kdar and Aljafara regions. The implementation of policies on transformation to organic farming might therefore be most fruitfully targeted to this region since younger farmers are more likely to engage in and adopt new farming practices.

In the research sample selected from the three main agricultural regions in Libya, all the respondents were male and most had a relatively good level of education. Mather and Adelzadeh (1998) note that the level of education of farmers determines their ability to interpret information. Therefore, people with higher educational levels are more able to interpret information than those who have less or no education. Furthermore, many studies suggest that younger farmers with higher levels of formal education will have a better understanding of organic farming, since education levels affect the use of agricultural information and the implementation of new agricultural practices that are important to any transformation to organic farming. This is supported, for example, by Anim (1999), who found that more educated farmers tend to adopt organic farming methods more quickly than less educated farmers.

Thus, in accordance with these findings, it is suggested that the policies and stakeholders in Libya should focus on farmers who obtained high school and university qualifications (which accounts for 47% of the sample respondents), rather than other educational criteria, in relation to conversion to organic farming.

Designing .educational programmes which lead to the achievement of a successful transformation to organic farming in Libya is vital. Therefore, it is suggested that the Tunisian experience in this matter should be followed in Libya. In the researcher's interview with the Director of the Biological Centre in Tunisia (2006), Professor Ben Khedher states that that an education programme should be continued by meeting with farmers and the course should be practical and simple according to farmers' abilities. In my view, the education programme plays a real role to create awareness of the whole system and to implement the system in the correct way. In addition, the education curriculum should be well designed, to achieve the goal of the programme and should be implemented horizontally to reach all farmers across the country. Thus, it can be deduced that relevant policies, if they are to be effective, should be aimed at younger and more educated farmers.

The results also show that the majority of the farmers have long farming experience; this is crucial to managing their farms. High levels of experience are necessary for farmers to make correct decisions and actions at the right time. The farmers may have a good understanding of farm management practices and it is important for policy makers to build on this experience to encourage organic farming principles. The analysis shows that there is a significant relationship between farming experience and formal education. Further analysis of the data shows that the mean period of experience for farmers in Libya is 22.8 years. Farmers with 10 to 15 years experience also have a relatively high level of education; this might positively affect the implementation of the policy on transformation to organic farming in Libya. Such farmers may better understand organic concepts. The findings of the level of farmers' experience in Libya is supported by other research findings, such as research conducted in 2008 in Norway, which found that the average of organic farmer experience was nearly 22 years of farming experience, whereas the average conventional farmers experience was 25 years( Matthias *et al.*, 2008) .However, another study, carried out in Nigeria, showed that 56.7% of the organic farmer respondents had 6 to 10 years farming experience (Adesope *et al.,* 2008).

The average farm size covered by the sample is 18.3 hectares. Margulies (1985) argues that farm size on its own has no absolute meaning but productivity may vary with soil type and the crops cultivated. Whereas some researchers have pointed that farm size has an effect on risk and farmers' desire to adopt organic farming. Issa (2010) found that main reasons for organic adoption were farm size and farm type. Therefore, organic farmers tend to have a small farm size (1-99 hectares), while the desire to avoid the market risks associated with organic farming and which could directly affect farm income is more likely to be expressed by large non-organic farms.

This finding partly explains why non-organic farms in Devon in UK were larger than their organic farms. Therefore, this finding is supporting transformation to organic farming in Libya because the farm size mean in this study was 18.3 hectares and shows that the majority of farms (55%, which is 145 out of 277) in this study within the 5-15 hectare size. So this finding implies that more than half of the farms in Libya are small-sized. This finding of this study is supported by that of Murphy (1992) who stated that 43% of organic farms in England and Wales were under 5 ha. Moreover, a study conducted in South Africa found that most of the farms converted in South Africa were horticultural holdings and smaller than the average commercial farms (Niemeyer and Lombard, 2003).

However, other studies in Germany and one from the USA do not support Murphy or Niemeyer and Lombard. Instead, the Germany and USA findings were that organic farms were larger than conventional farms

On balance, therefore, as 55% of conventional farms in Libya are small sized, the findings indicate that they are appropriate for conversion to organic farms, as this size of farms can be transformed to organic more easily. This is supported by the findings by some researchers that the average farm size of organic farms in most countries was smaller than that of conventional farms (see United States: Harris *et al.*, 1980; Lockeretz and Anderson, 1990; Denmark: Dubgaard and Soerensen, 1988; Canada: Henning *et al.,* 1991).

This research also suggests that the relatively large size of current farms may influence the decision of farmers to transform to organic farming. This is because the farmers will still maintain non-organic farming practices whilst they practice organic farming on sections of their farms. This may be attributed to their familiarity and experience with non-organic farming. They would not risk transforming the whole of their farm to organic farming when they may be uncertain about the production and income generation outcomes. They will thus maintain farm sizes that allow them to practice both organic and non-organic farming. Most farms (63%) in the surveyed sample were mixed (dairy, livestock and horticulture). This is a good indication since it means that the farmers can perhaps practice organic farming on different aspects of their agriculture. There is strong evidence that it is not the farm size, but infrastructure like access to metalled roads, markets, and irrigation systems which determines the extent, success and profitability of agricultural production (Chand, 1995). Thus, farm sizes per se may not aid the transformation to organic farming in Libya but the availability and accessibility of infrastructure are the main determinants.

Furthermore, it should be noted that one of the requirements and conditions for establishing organic farming is to lay out the farming far away from any polluted area. This condition is already being implemented in some countries such as Tunisia. Professor Ben Khedher, the Director of the Biological Centre in Tunisia, agrees that Tunisia has achieved the idea of converting to organic farming and in accordance with the EU standards, and thus Tunisia could be a leader in organic farming systems in Africa (2006).

The majority of owners of Libyan farms also manage their farms. Stroebel (2004) notes that ownership of agricultural related assets influences production and marketing decisions among smallholder farmers. This means that farmers who own their farms have a direct influence on what to produce and where to market their produce, unlike those who do not own their farms. This also indicates that farmers who own their farms are in the position to make decisions related to agricultural activities, also unlike those who do not own their farms. The finding of this research is supported by the Soil Association in the UK (Crucefix,1998), which states that many of the farmers who do not have title to their land are reluctant to plant permanent crops. Obtaining title for reservation land is a long and complicated process, and Professor Ben Kheder (2001) points out that ownership is one of the main practical obstacles and constraints to conversion in Mediterranean countries. Therefore, uncertainties about ownership and access to land are real obstacles to conversion in those countries, as farmers have to be sure that they will be able to benefit from investing in such a process.

However, the current farm ownership structure in Libya is conducive for a transformation to organic farming since the farmers can make quick and independent decisions to adopt organic farming practices .Therefore, the findings from Professor Ben Khedher study on ownership in Mediterranean countries would not be applicable in Libya. The results of the present research indicate that in Libya, 96% of farmers have responsibility for decision making on their farms. However, it is noted that their decision to adopt organic farming practices is dependent on the availability and accessibility of agricultural infrastructure.

### 7.2 Agricultural Infrastructure Availability and Accessibility

The study has confirmed that agricultural infrastructure plays a major role in the development of the farming sector in Libya. For example, the increase and growth in the agricultural areas and production from the 1960s to date can be attributed to improved availability and accessibility of general infrastructure in Libya.

The roles of six types of agricultural infrastructure, namely roads; communication and information services; processing infrastructure; irrigation and public access to water; agriculture and research extension services; and credit and financial institutions were found to be critical to the development of the agricultural sector in Libya. Indeed, it is indicated that the availability of agricultural infrastructure is one of the most important determinants of growth and development in the sector.

The research indicates that most farms have nearby roads but these roads do not lead to the inside of their farms. This disadvantage affects their productivity. However, this finding of the availability and accessibility of current roads implies that farms are facing challenges to achieve higher productivity and sufficient marketing, and higher profitability with technology. This is supported by Rostow (1960) who argues that an increase in agriculture production and the productivity of the agricultural sector is conditioned by the expansion and improvement of transportation. Poor roads constrain productivity and profitability as they increase the difficulty and cost for farmers to haul their inputs to the farm and their outputs to the market (Chris *et al.*, 2006). Furthermore, this is supported by Chirwa (2004), who found that the use of poor roads in transportation increases the cost of transportation, especially for small farmers, who would have difficulty with such roads in marketing their production and reaching the right markets. It is also supported by Temu *et al.* (2003) who conclude that lack of the necessary infrastructure to facilitate transportation leads to high cost of delivering goods, crops and agricultural machinery.

Most of the farmers indicated that even though fixed telephone and mobile services are available to them on their farms, internet services are available to slightly less than half of the respondents. The availability of fixed and mobile telephone services may facilitate communication but internet availability is more important for the dissemination of data between the various government institutions of agriculture and the farmers. Considering the large size of Libya, the use of the internet in the sharing of information on new agricultural practices is very significant. However, the insufficient availability and accessibility of internet services is one of the challenges to achieving agricultural development. This is supported by the FAO (1996:15) statement that "better communications are a key requirement to agricultural development. They reduce transportation cost, increase competition, reduce marketing margins, and in this way can directly improve incomes and private investment opportunities". Therefore, development of an internet service in the study's agricultural regions might have particular importance in an effective transition to organic farming, as the internet is time and cost effective.

The farmers indicated that an improved food-processing infrastructure would encourage them to increase their productivity because any excess produce could be re-processed. Waste processing infrastructure to help them dispose of agricultural waste more efficiently was not available to them at the farm level. Most of these facilities are at the regional level. However, the lower availability of a processing infrastructure in these agricultural regions might affect accessibility to the markets and be responsible for the deteriorating performance of the agricultural industry. This is supported by Barghouti *et al.* (2004), who state that processing facilities are critical for improving market access, which has a positive effect on the capabilities of farmers in many developing Third World countries. Moreover, poor processing infrastructure, such as post-harvest infrastructure, is a major cause for the deteriorating performance of the agricultural industry (see for example, Ramaswamy, 1995; Kaul, 1997).

The research found that road transport, telephone and mobile telephone services are available to most farmers. This means that they can easily communicate with the managers of processing plants. However, the cost of transporting their produce from their farms to the processing plants, and the time involved in doing so, do not encourage them to increase their productivity.

The climatic environment of Libya makes water a very important resource in agricultural production. The farmers noted that the main sources of water, such as well water and re-used water are mainly available at the regional level instead of the local level where most farmers operate. However, despite the

Great Man-made River supplying water to many agricultural regions, the limitation of water in Libya is considered one of the challenges that constrain agriculture sector development. Therefore, the use of appropriate irrigation systems to utilize water both efficiently and economically is considered one of the main issues of this study. Venkatachalam (2003) points out that the introduction of technology such as sprinkler irrigation may lead to cropping pattern change, which would move from those crops that causes soil erosion to crops that may protect the soil.

Therefore, farmers have indicated that they have access to other sources of water supply through the use of drip irrigation systems, sprinkler irrigation systems and conventional irrigation systems. Moreover, farms which use drip irrigation in the farms supplied by water from regional wells noted that they have tanks in the farm to collect the water then deliver it again by using water pumps for the drip irrigation system to irrigate the farm. Therefore, the fact that a reasonable proportion of farmers are using drip irrigation and sprinkler irrigation in the agricultural regions implies an effort to conserve water. It would suggest that farmers who use drip and sprinkler irrigation are aware of the challenges for agriculture in limitation of water and the importance of using irrigation technologies. This finding is supported by Karasov (1982), who considers that the greatest challenge for agriculture is to develop technology for improving water use efficiency. This is further supported by Howell (2001), who argues that irrigated farming is the most crucial element of agriculture in general and particularly in providing fruit, vegetables and cereal to meet the needs of people and livestock.

The information gathered from the farmers indicates that they are concerned that agricultural services such as research centres, training centres, agricultural and commercial banks, and agricultural extension services are only available at the regional level. This means that the farmers have to travel long distances to access these services. This takes them away from their farming activities and distracts their focus. For small, owner-manager and family farms, there is a significant cost in terms of time away from the core business in order to attend meetings or briefings.

However, the farmers indicated that the availability of agricultural infrastructure can enable them to adopt new agricultural practices when opportunities arise. For example, 65% of farmers said that available infrastructure enabled them to use manure fertilizer, which is a component of organic farming. The use of manure fertilizer is important to successful organic farming. This finding is supported by Smith *et al.* (1993) and Escobar and Hue (2007), who point out that organic manure is used to provide essential nutrients to crops. Thus the availability of agricultural waste processing plants for the production of organic fertilizers closer to the farms will boost the transformation to organic farming. The farmers are also of the view that the availability of infrastructure such as communication services enables them to adopt farming practices such as crop rotation that enhances the long-term fertility of the soil.

From these findings it seems that the choice of farm produce and farming practices by farmers are influenced by available infrastructure. This includes roads, communication and information services, processing infrastructure, and support services. This finding is supported by those of other researchers such as Ahmed and Hussain (1990), who demonstrate that there is a positive correlation between the use of fertilizer and the improvement in the quality of roads. This finding implies that the implementation of fertilization practices is correlated with the availability of fertilizer, which is important for soil fertility. Therefore, fertilizer availability is correlated with the current availability and conditions of agricultural infrastructure in a particular place. Moreover, in Africa, rural road construction has been found to be associated with increases in agricultural production (Anderson *et al.*, 1982).

It can be deduced from the research that agricultural infrastructure plays an important role in the use of major inputs such as manure fertilizer to agricultural production in Libya. The farmers indicated that the availability of infrastructure enhances their ability to use manure fertilizer and improved seeds, which are critical to the transformation to organic farming in Libya. The farmers were unanimous in their views that agricultural infrastructure availability encourages transformation to organic farming practices, which may lead to improved soil fertility and conservation through crop rotation and biological pest control practices and the increased use of manure fertilizer.

The importance of agricultural infrastructure to organic farming transition in Libya was also stressed in interviews with government officials and other agricultural sector stakeholders. They noted that infrastructure has an important role in the development of agriculture in Libya. It was confirmed that electricity, roads, and communication facilities have had a great impact on the expansion of agricultural activities in Libya; contributing to increases in agricultural production. Therefore, it can be said that agricultural infrastructure in Libya has a major role in making a significant shift in conventional farming systems to organic farming practices. This finding is supported by previous research findings by Gibson and Rozelle (2003), Fan *et al.* (2003), and Wanmali and Islam (1995), which have shown a positive relationship between public investment in infrastructure and agricultural growth.

The involvement of the government in the provision of agricultural infrastructure, especially since the 1970s, has led to the development of roads, new irrigation systems, establishment of agricultural banking facilities, and agriculture and industries related to the agricultural and food production. This existing infrastructure, whilst developed to support more intensive farming, could provide a sound platform for a transition to organic methods. However, much more could be achieved if such key infrastructure was to be made more accessible at the farm level.

The provision of infrastructure has helped greatly in making a real change in the economy with a resultant increase in the number of people involved. There has been an increase in agricultural production, which has led to the export of excess production to regional or international markets thus earning the country some foreign exchange. Temu *et al.* (2003) observe that poor infrastructure and services raises agricultural production costs, and under-served farms and farmers suffer higher levels of risks and uncertainty in their production and marketing endeavours. They tend to be more risk averse, which results in them keeping to their old farming practices. The research suggests that if agriculture is to make a more significant contribution to the economy of Libya in terms of employment and foreign exchange generation, then the critical infrastructure must improve. The necessary changes, as borne out by the historic evidence since the 1960s, must be of quantity, quality, and location accessibility of agricultural infrastructure provision. It is likely that foreign exports could be a driver for premium quality organic produce and in this case, infrastructure provision will be a key issue.

Since the 1970s, when the Libyan government decided to diversify its economy to include agriculture, the state has allocated resources to agricultural infrastructure provision. The intention was to establish and improve the general infrastructure for development of the wider economy and for the agriculture sector in particular. This led to the development and improvement of roads and new irrigation, and the establishment of agricultural banking facilities. It also encouraged the growth of farming and industries related to the agricultural and food production and processing. The Libyan government recognised that infrastructure has an important role in the development of agriculture and has great impact in terms of expanding agricultural activities. It was accepted by stakeholders and experts that improvements in critically important infrastructure will increase agricultural production.

The study confirms how the provision of infrastructure has greatly helped the development of agriculture in Libya. In general, agricultural production at local, regional and national levels has increased. Reflecting these increases, a large number of people are now employed or work for themselves in agricultural projects and related industries. It was also found that the increased agricultural production has led to exports of excess production. This has occurred from the local and regional areas of production to national population centres and, to a lesser extent, abroad as well. Sales to international markets thus generate foreign exchange, albeit at a modest level, and perhaps indicate future potential for value-added products.

The literature suggests that the accessibility to infrastructure services in a country determines the level of economic activity. This pertinent to the Libyan case study and was identified, and its importance is recognised by key stakeholders. In the previous section, the study has highlighted how certain aspects of agricultural infrastructure, such as roads, communications and information systems, irrigation systems and agricultural services, are only present at the regional level in Libya. This level of availability raises issues for farmers of the need for local accessibility of infrastructure. This clearly affects their agricultural practices and their farming decisions. Most farmers are of the view that accessibility to transportation systems to and from their farms is difficult. This issue needs to be addressed since transformation to organic farming will be affected by availability and accessibility of effective transport systems. With added-value produce, and especially with exports of organic produce to overseas markets, good transportation is essential.

Furthermore, accessibility to processing systems and irrigation and public water systems is also difficult. These factors not only influence and test current farming practice, but will challenge any transformation to organic farming systems. The study shows that communication and information systems are only accessible to about a third of the farmers. Conversely, this means that around two thirds of the agricultural producers have little effective communication through which new ideas can be disseminated. Easy availability and accessibility of communications systems will not alone promote the development of organic farming in Libya, but they are critically important. Lack of such networks will certainly prove to be a barrier to transformation. However, the lack of a flow of information to conventional farmers in Libya would be one of the obstacles to transformation to organic farming. This is supported by Kafle (2011), who found that in Nepal, the lack of adequate information on organic agriculture seems to be the major reason for non-adoption of organic vegetable farming by the conventional farmers.

The other agricultural infrastructure such as roads, processing systems, irrigation water systems and agricultural services also need to be available and easily accessible. This would have to be to a greater proportion of farmers at the local level in order to encourage the transformation to organic farming.

The research found that access to agricultural research and extension services and credit and financial institutions is difficult for the majority (60% and 57% respectively) of farmers. This situation does not facilitate conventional agricultural development any more than the transformation to organic farming. This finding is supported by a study conducted In Iran, which shows that among small farmers, extension activities and training are the main determinants of farmers' perception and motivation in organic farming (Rezfanfar *et al.*, 2011, in Kafle, 2011).

Along with these findings, most farmers expressed their dissatisfaction with the availability and accessibility of research centres, training centres, extension services, agricultural and commercial banks, processing infrastructure, waste processing infrastructure, and access to re-used water. Presented together, these indicate serious challenges to the transformation to organic farming in Libya. Thus, if organic farming is to be recognised and embraced by farmers, this will need to be addressed at the national, regional and local levels.

The research shows that whilst government policy and investment have addressed a number of key issues of infrastructure provision since the 1960s, more needs to be done. While a certain amount of key agricultural infrastructure has been provided, this needs to be modernised and extended. Inefficiency in some agricultural bodies has led to poor maintenance of existing infrastructure and often a general lack of improvement in infrastructure. Furthermore, the slow development of other agricultural services, such as processing facilities, and the near absence of infrastructure for production of improved seeds jeopardise any future transformation to organic farming. These issues affect the development of farming in general and the transformation to organic farming practices in particular.

However, the research acknowledges that there have been some improvements in the provision of infrastructure in Libya and these have aided farming development. It was confirmed by the study that while infrastructure such as electricity supply, roads, communication systems, and irrigation systems are spread widely across the country, they are concentrated especially in developed coastal areas. In addition, the construction of the Great Man-made River has made more water available throughout the year and this has had major impacts on agriculture, affecting both seasonality and spatial distribution. It is now possible to cultivate and grow crops in many areas where previously this was impossible. The risk of rainfall failure is also offset by readily available irrigation water supplies. Perhaps linked to this change there has been increased awareness of the importance of agriculture at a national level, and farmers are more knowledgeable about available markets. However, it seems that despite these improvements and the increased political awareness of the importance of food production, some essential support, such as promoting and addressing organic food regulations, is still lacking. In addition, customer demands for organic produce are still not clear. Therefore, the development of this issue is considered one of the most important factors in developing the organic sector. However, in the case of Libya, the researcher suggests that the establishment of a body of certification for organic commodities is the most important step in order to develop organic farming demand in Libya, both in the internal and external markets. Furthermore, to sell organic commodities as cheaply as non-organic ones is a good way to promote the change to organic gradually.

These factors described and discussed above have had a big influence on the development of agriculture in Libya. On the one hand, the provision of infrastructure resources so far provides a basis for diversification and perhaps a move into the organic sector. On the other hand, the serious shortfalls in resources, identified by both farmers and other stakeholders or experts, will hinder aspirations for future moves into the organic farming market. It is clear that further development of Libyan agriculture and in particular diversification into new or added-value markets such as organic farming will necessitate a major upgrade in critical infrastructure. It is also indicated from the stakeholder feedback that such provision will need to be undertaken as a broad package since a failure in any one area of delivery will have repercussions elsewhere.

The research found that the provision of roads and electricity led to the introduction and use of agricultural machinery in most farming areas in Libya. This further contributed to the supply and use of improved seeds and fertilizers. These findings were confirmed by the stakeholders, the farmers and in the published literature. Improved road systems since the 1970s have contributed significantly to the development and growth of the agricultural sector at local, regional, and national levels. For example, the construction of key road networks between the south and the northern coastal zone has contributed to increased cereal production in the former. The availability of metalled roads has meant easy transport of machinery, fertilizers and good, quick access to markets. However, it was emphasised by the farmers that although the quality of the major roads is good, that of the ancillary roads leading to the farms requires investment to improve standards. For organic farming, this may be a serious barrier to speedy transport off the farm of a high quality, added-value product, perhaps with a shorter shelf-life than other products.

From interviews with stakeholders, from the responses of farmers, and from the AOAD (2009) report which showed the development of agricultural commodities during 1970-2007, this development of agricultural commodities is due to the improvement of agricultural infrastructure, which has led to increased agricultural activity. This in turn has contributed to a growth in the number of people engaged in agriculture. Current provision of agricultural infrastructure has contributed greatly to agricultural production in many parts of Libya and has helped improve educational standards. This was confirmed by the qualification levels demonstrated by the farmers sampled, and has implications for future diversification. The analysis of the literature suggests that educational level may be significant in determining the interests and capability of farmers in transformation to organic systems. A high level of farmers' education in Libya is considered to be a good way to facilitate transformation to organic in Libya. This finding supported by Anim (1999), who found that more educated farmers tend to adopt organic farming methods more quickly than less educated farmers. It is also supported by the finding of several studies from other countries that have reported organic farmers to be better educated than their conventional counterparts (Padel, 2001). However, although the finding by Padel (2001) was not in relation to conventional farmers when the research was conducted, the finding is considered to be a strong motivation for farmers in Libya to convert to organic easily because they obtain a high level of education.

The availability of agricultural facilities such as roads and processing infrastructure helps to reduce waste in agricultural production. This is mostly through better access to markets, storage, and processing facilities. In spite of this, the farmers noted that many key infrastructure resources are not easily available and improvements are needed. Again, this may be an important issue for organic production systems. However, it is also indicated that improvement in efficiency in the sector can be attained if modern infrastructure is provided and made readily available.

The research suggests that agricultural processing industries in Libya are inefficient and cannot utilise all produce from farms. Comparison with similar countries suggests that Libya, perhaps because of the period of political isolation, is lagging behind. In many instances, surplus agricultural production goes to waste as there are no storage facilities and the harvests or crops cannot be processed. This would have serious implications for organic farming outputs. A typical example provided by the farmers was the quantity of dates that go to waste for lack of processing plants and storage facilities. This finding is supported by the finding from India that farmers were losing a substantial quantity (20-30% of the total harvest) of agricultural produce due to the lack of adequate infrastructure and post-harvest technology (see Singhal, 1995; Kaul, 1997; Viswanathan and Satyasai, 1997). It is also supported by the finding of many studies which have also highlighted that poor post-harvest infrastructure is a major cause for the deteriorating performance of the agricultural industry (see for example, Ramaswamy, 1995; Kaul, 1997).

However, this situation does not auger well for increased production or for diversification into other markets such as organic. This view is supported by Barghouti *et al.* (2004) who state that processing facilities are critical for improving market access, which has a positive effect on the capabilities of farmers in developing Third World countries in allowing them to compete with their counterparts in the developed countries.

Farmers can only be encouraged to increase their production and to test new markets if they are confident that their output and efforts will not be wasted.

The extensive literature in this field confirms that an agricultural infrastructure is the basis for the development of farming. This is noted as especially important in emerging Third World economies. In Libya, the diversification and growth of agriculture at national, regional and local levels has been facilitated by the improved availability of infrastructure since the 1960s. This has led to an increase in agricultural areas and some, in places considerable, modernisation.

The Great Man-made River is perhaps the most striking example of this. However, the research found that much still needs to be done, both in the maintenance of current infrastructure, and the improvements in specific areas of service and support. This study confirms that the availability and accessibility of agricultural infrastructure has helped in the introduction of farming machinery in areas deep in the desert. It has also helped in the distribution and use of various production inputs such as seeds, fertilizers and insecticides. Nevertheless, these infrastructural supports are often not readily available and accessible to local small-scale farmers.

Again, the research found that agricultural services such as the Agricultural Bank have enhanced the development and growth of the agricultural sector in the Libya. The banks are a major pillar supporting agriculture and general economic growth. Their direct involvement with farmers has facilitated agricultural development, and the policies of the banks have encouraged many people into farming. However, it was noted by stakeholders and farmers that agricultural financial infrastructure services are mainly concentrated in the major cities. This means that they are not easily accessible to the majority of farmers who have to travel long distances to do business with the banks. This finding is supported by many researchers who have found that where there is a lack of access to finance the farmer, including credit constraints, this negatively influences the plot size (Hazarika & Alwang, 2003), fertilizer use (Croppenstedt *et al.*, 2003), and total productivity (Freeman *et al.*, 1998). Furthermore they argue that lack of access to financial services reduces farmers' potential to make savings. The existence of long distances between farmers and banks increases costs and reduces access to credit required for stimulating production and investment in technology. The finding is also supported by that of Khandker and Faruqeel (2003), who provide evidence of a close positive correlation between institutional credit and agricultural output, consumption, and other household welfare indicators. Financial institutions need to provide access to credit and savings for farmers. This is further supported by Barghouti *et al.* (2004) who indicate that the availability of credit significantly improves farmers' ability to venture into new lines of business. This enables them to make the necessary investments in the additional infrastructure required for these ventures.

Overall, the improvements observed in the Libyan agricultural sector are the result of government intervention. In particular, this is attributed to the availability and accessibility of agricultural infrastructure established since the 1970s. The importance of money from oil revenues and the pressures of the international isolation in the 1980s and 1990s have played critical roles in this investment and provision. Such infrastructure has played a great role in the development of the current agricultural sector but it has also facilitated moves towards intensive, high-input, agri-industry. Furthermore, many of the more isolated farmers are placed under a major disadvantage by the present networks of infrastructure. Much could be achieved if the infrastructure was more widely available and accessible to these farmers.

## 7.3 Effect of Infrastructure on Farming Practices in Libya

The farmers stated that they are not satisfied with the current agricultural infrastructure availability and accessibility. They indicated that the situation does not promote the development or diversification of agriculture. Farmers are not very satisfied with the standards and quality of a number of key agricultural infrastructures. Production inputs, such as fertilizers, insecticides and seeds, are sometimes lacking and even if they are available, their prices are very high. This does not encourage farmers to adopt new farming practices or increase their production.

One area of particular concern is access to loans by farmers. For example, accessibility to agricultural loans on flexible payment terms and reduced interest will encourage farmers to implement new farming practices. In this regard it is expected that the role of Agricultural Banks, which is vital to diversification or transformation to organic farming, needs to be critically assessed. However, the satisfaction levels of farmers with current availability and accessibility of agricultural infrastructure is to an extent subjective. The specific issues depend on farm location, and so the use of three major study areas has helped to balance the locally-based concerns. It seems that overall agricultural infrastructure needs improvement in order to enhance Libyan agricultural development. The evidence suggests that where farms are accessible by roads, served by effective communications and in contact with agricultural service centres, agricultural societies, factories and markets, the farmers are satisfied. On the contrary, on farms with little infrastructure and where the services are lacking, farmers are dissatisfied. These feelings will obviously manifest themselves in the desire or otherwise to embrace new ideas and opportunities.

The research identified a noticeable lack of satisfaction with respect to water and irrigation systems. This was also the case for information sources and guidance centres. The country is vulnerable to wide fluctuations in rainfall and so the availability of dams and efficient irrigation systems improves farming reliability, practice and confidence. With the marked exception of the infrastructure related to the Great Man-made River Project, it was noted that the present irrigation networks are not properly maintained, and many water wells are collapsing. Farmers are thus constrained in expanding their farming activities because of water shortage. The situation with irrigation systems is exacerbated by the poor quality electricity supply. This is unreliable and leads to serious losses of crops and damage to electric water pumps that operate the irrigation systems.

It seems that agricultural infrastructure and potential conversion to organic farming systems are strongly linked. The research found a relationship between the availability of agricultural infrastructure and choice of farm produce by farmers. Infrastructure such as roads, communication and information services, processing infrastructure, access to irrigation systems, research and extension services, and credit and financial institutions, strongly influences the choice of produce of farmers. It was also noted that availability of, and accessibility to, agricultural infrastructure are important to the use of particular farm inputs and to the adoption of new farming practices. The availability of such infrastructure may aid the promotion of transformation to organic farming in Libya, and absence will undoubtedly hinder it. Such infrastructure can enable farmers to implement organic agricultural practices and other technological innovations to prevent environmental damage. These practices include sustainability of soil fertility, use of manure fertilizer instead of chemical fertilizer, soil rotation, crop rotation, and the use of biological pest control. A particular example which came to light was that the availability and accessibility of agricultural infrastructure has helped the introduction of farming machinery into areas deep in the desert. Areas lacking such infrastructure are disadvantaged in any such innovations. It has also helped in the distribution and use of various production tools such as improved seeds, fertilizers, and insecticides.

The research emphasised the importance of agricultural infrastructure to farmers' decision making. The availability and accessibility of agricultural infrastructure influence key decisions of farmers such as on their agri-land holding size, crop production, agriculture practices, new technology, new agricultural methods, and ultimately, the profitability of their farms. Since the 1970s, the improved availability of agricultural infrastructure such as markets, roads, communications etc. has contributed to increases in farmers' profits. It has also facilitated the implementation of various other agricultural development projects. There has been increased production and diversification of crops cultivated. Over this period, the availability and accessibility of agricultural infrastructure enabled the introduction of new agricultural produce such as bananas, apples, and various cereals. Animal husbandry has also improved and in particular, livestock, poultry and dairy production have become more important.

The farmers acknowledge that though there has been increased available infrastructure, their current capacity, quality and efficiency needs further improvement. They suggest that support needs to expand if they are to make a significant impact on agricultural development in Libya. Agricultural infrastructure enhances production and reduces costs, and therefore increases profitability. The present infrastructure requires maintenance, improvement and modernisation. Feedback indicates that more effort is needed to develop the role of agricultural research, training centres, agricultural banks, and irrigation systems. The modernization of poultry production units was a particular concern that was raised.

The farmers cited the establishment of research centres as facilitating research in agriculture. However, they felt that more needs to be done on the actual dissemination and implementation of research findings. Again, it was noted that the maintenance of irrigation systems is needed to prevent substantial loss of water since most of the irrigation systems are quite old and these inefficiencies lead to significant water loss. Investment in the modernisation of irrigations systems would lead to much better production practices, and this was confirmed by interviews with key stakeholders too.

Roads have greatly facilitated the provision and use of agricultural machinery and equipment. Furthermore, they have helped farmers transport their produce to key markets such as the main consumption centres. These are mostly in the north of Libya where the population is concentrated. However, whilst there have been some general improvements in road networks, these need to be expanded. A number of agricultural roads are dilapidated and this affects the cost of transportation. There is also a cost in terms of the damage to vehicles and other machinery and equipment transported over such rough roads. For any future transformation to organic practices, improvement in the road transport network is vital. This is to get produce to the main north coast centres for consumption and for processing, and also to access the major ports and airports for export of value-added products.

The importance of agricultural infrastructure to the development of agriculture is much appreciated by expert stakeholders and by farmers. It is reflected to some extent in the development of agricultural commodities which are a result of the agricultural infrastructure development mentioned in the AOAD (2009) statistics report and in the literature reviewed in this research. However, there are complications, since this access to infrastructure is not necessarily environmentally benign. Researchers have noted that improved agricultural infrastructure availability can increase environmental problems such as the deterioration of land and contamination of water sources by agrochemical use. In other words, infrastructure does facilitate agricultural transformation and in the case of Libya since the 1960s, it has encouraged and allowed the move towards high input agri-industrial farming. Chemical fertilizer and pesticide usage in Libya have increased over the years with improved agricultural infrastructure. Thus, the management of available agricultural infrastructure required careful management. An appreciation of a holistic development of all necessary infrastructures to promote the sustainable development of agriculture should be considered in order to achieve the socially and politically desired goals.

Infrastructure plays a vital role in agricultural development and Wanmali and Islam (1995) note that there is a positive relationship between availability and accessibility of infrastructure and agricultural growth. Existence and use of technology in agriculture depends strongly on both physical and institutional infrastructures that have an important strategic role in agriculture growth (Mellor, 1976). There is a growing interest in infrastructure development in Libya. It can be inferred from the findings of this research that the availability and accessibility of agricultural infrastructure and services lower agricultural production costs. Agricultural infrastructural availability and accessibility benefit farmers in the reduction of wastage and transportation costs, better exposure to improved and modern agro-practices, improved accessibility to inputs, improved access to farms and other farmers, and linkages to the credit and developmental institutions. These benefits encourage new agricultural practices and promote the development of agriculture.

The farmers welcome the introduction of modern technologies in agriculture. However, they stressed the need for proper planning and education before their introduction in order that they may contribute to improved productivity. The current agricultural infrastructure in Libya, though basic, is of vital importance in facilitating the development of the agriculture sector and should be maintained. From the above discussion, it can be inferred that there are strengths and weaknesses in the agricultural infrastructure in Libya. The research identified the strengths of agricultural systems in Libya as follows:

- Spread of infrastructure such as electricity supply, roads and communication systems since the 1970s;
- Availability of irrigation systems to most of the study area;
- Development of markets and increased awareness of them by growers and producers;
- Construction of the Great Man-made River; and

- Emergence of agricultural research centres and other educational support.

These strengths benefit farmers and can be a platform for future transformation to organic farming if they are considered in totality. For example, the availability and supply of electricity needs improvement and to be linked to availably, and importantly maintenance, of irrigation systems.

The research also identified some weaknesses in the availability of agricultural infrastructure. These are listed below:

- Absence of modernisation and lack of improvements;
- Inefficiency of a number of agricultural bodies and institutions;
- Absence of processing facilities;
- Absence of infrastructure for the production of seeds;
- Lack of maintenance for the infrastructure; and
- Poor road quality to individual farms off the main transport networks.

Feedback from both expert stakeholders and from farmers suggests that these weaknesses hinder the future development of the organic farming. In particular, they may impact adversely on any transformation to organic farming in Libya. Addressing these issues requires a strategic vision for agricultural development that approaches the sector in a holistic manner.

## 7.4 Barriers to Organic Farming in Libya

National agricultural policy formulation implementation was identified as a major barrier to the development of organic farming in Libya. This is evidence from all three parts of the research triangulation. The development of appropriate policies to consider the present agricultural infrastructure and the need to increase the sector's contribution to general national economic growth will enhance prospects for modernisation. The farmers noted that such policies can be effectively achieved if implemented through agricultural agencies at the local level with national level support.

The transformation to organic farming can be facilitated through the modernisation of agricultural infrastructure in Libya. This is capital intensive and beyond the means of individual farmers or of the regional agricultural unions. Increased state support through funding to improve existing infrastructure such as improved roads that extend to all areas of agricultural potential, linking them with markets will enhance the process of transformation to organic farming. In addition, the development of more agricultural service centres that promote the introduction of modern technologies, especially in the areas of irrigation and modern operational systems, will minimise barriers to organic transformation.

The respondents acknowledge that finance is crucial for the development of the agricultural sector in Libya. However, they noted that very few studies have been done to determine the real financing requirements of farmers. It appears that though the government is making an effort to improve agricultural infrastructure in Libya this is done without effective consultation with the farmers. A better approach would be to involve the farmers in the decision-making processes aimed at transformation. The key expert stakeholders and the farmers themselves confirmed this finding. It is suggested also that a task for the main agricultural research centres should be to undertake a detailed review of the issues in terms of infrastructure and diversification. This could then lead to a coherent political strategy.

The geographical location of Libya gives it a major incentive to promote organic farming since it is close to international markets in Europe. Here there is significant demand for good quality organic produce, and comparison with other producers such as Morocco, Tunisia and Egypt, suggests that Libya could improve its performance. This locational advantage can be turned into reality once stakeholders in Libyan agriculture are sufficiently knowledgeable about organic farming. For this transformation to be effective there is urgent need for inclusive dialogue about the development and implementation of agricultural policies. Though stakeholder and farmer feedback suggests that there is the will to promote development of organic farming in Libya, current practices both at the policy level and on the ground do not encourage its achievement. The formulation and implementation of policies need to be better coordinated to resolve the key issues. In particular, this study confirms that a vital matter to be addressed is that of the quality, availability, and accessibility of critical agricultural infrastructure that otherwise acts as a barrier to agricultural development.

Finally, in terms of any future transformation to organic farming and the development of an export market, other changes would also be necessary. The support infrastructure in Libya would need coordination to provide for the necessary training of farmers and agricultural department officials in order to enable farmers to meet rigorous international standards and validation processes for organic labelling. Moves towards the application of organic methods to supply healthy food to internal markets could be achieved in part by changes in farming without meeting the international standards.

However, if the desired outcomes include export of products then the demands for regulation will be much more severe. This matter of validation and certification is a serious issue that government and research centres would need to address. It may also be the case, though this research has not extended so far, that particular market segments may, in terms of transformation, be easier than others might be. For example, the potential for fruit production and horticulture in Libya is considerable and might be easily expanded and organised on an organic basis for domestic and export markets.

Major grain production from the more fertile and long-established arable areas in the coastal belt, could similarly be easier to move to less intensive methods. However, the extensive new arable areas on the re-claimed arid lands irrigated by the Great Man-made River are highly dependant on inputs of inorganic fertilisers and pesticides.

Transformation of these systems will require major changes in nutrient supply and pest controls. Again, it is suggested that a detailed feasibility study should be undertaken to consider if this is really possible or not. Ultimately, many of the changes advocated will be market-led, and therefore it is important that any serious attempt to transform Libyan farming in this way is underpinned by a rigorous assessment of the domestic market demand. Perhaps, with an increasingly affluent and educated middle class concerned about health impacts of intensively grown goods, and by adverse environmental impacts too, there will be a natural move in this direction.

## 7.5 Summary

This chapter discussed the findings of the triangulated research to consider how agricultural infrastructure in Libya might enhance or hinder transformation to organic farming. Several key issues, such as limited agricultural infrastructure and accessibility to farmers, were identified.

A number of barriers to the transformation to organic farming in Libya were also discussed, and suggestions were made as to how these might be addressed. These matters are mostly in the areas of policy formulation and implementation. Consideration of the literature, and in particular the examination of the performance of other case study countries, suggests that in principle, Libya could access export markets into Europe.

However, the discussion notes the serious and significant barriers to such aspirations. It was also found that there may be differences in the ease of transformation in terms of different crops and produce, and whether the aim is for export or for domestic consumption.

In the final chapter, these issues are brought to a conclusion and recommendations are drawn from the research findings on how the transformation to organic farming in Libya might be achieved.

# CHAPTER EIGHT

## CONCLUSIONS AND RECOMMENDATIONS

### 8.0 Introduction

The literature suggests that agriculture infrastructure is the most essential input regarding the development of agriculture. In Libya the feedback from expert stakeholders and farmers indicates that agriculture infrastructure such as transportation, electricity, water and irrigation systems, communication systems, and markets are critically important to the development of the industry. To foster diversification this infrastructure should be organized to achieve the maximum momentum of development in the agricultural sector. Ashok *et al.* (2006) state that irrigation; roads, markets, and literacy are the most important infrastructural variables in influencing total productivity. It has been noted that it is not the farm size, but access to infrastructure such as metalled roads, markets, and irrigation systems, which determine the extent, success, and profitability of agricultural production (Chand, 1995).

This chapter brings together the overall conclusions of the in-depth study focusing on the importance of infrastructure to the transformation to organic farming in Libya. The country does not have an established organic farming sector. However, it has developed infrastructure to support conventional farming and this has led to growth in agri-industrial production since the 1970s. Little was known about whether the present infrastructure could support a transformation to organic farming systems.

The primary aim of the research was to examine if infrastructure facilitates or hinders the diversification and possible future development of organic farming in Libya. The study argues that infrastructure plays a vital role in agricultural development. This follows the findings of Wanmali and Islam (1995) which note that there is a positive relationship between availability of and accessibility to infrastructure and agricultural growth. Furthermore, the presence and use of technology in agriculture, which has an important strategic role in agriculture growth, depends strongly on both physical and institutional infrastructure (Mellor 1976). This helps maintain existing jobs in the sector and increases the income of farmers. The availability of and accessibility to agricultural infrastructure is therefore integral to any diversification of agriculture and particularly the transition to organic systems.

The core objectives for the research were:

- To examine the current levels and provision of agricultural infrastructure in Libya;
- To explore the types of infrastructure needed to establish organic farming in Libya;
- To explore the effects of current infrastructure on farming practices;
- To assess the Libyan government's policies and attitudes to establishment organic farming; and
- To evaluate the critical barriers that may influence the establishment of an organic farming system in Libya.

The study used a mixed methods approach to collect data through questionnaires with farmers in three agricultural regions in Libya. Interviews were conducted with agricultural experts from both governmental and non-governmental organisations and individuals with a rich experience in agriculture.

## 8.1 The Key Findings

The study has identified a number of key issues in relation to infrastructure and agricultural development. These are:

- Efficient water management;
- Improved seeds;
- Post-production management; and
- Value-addition and marketing.

It was noted that there is insufficient provision of critical agricultural infrastructure, especially in terms of processing infrastructure and irrigation systems. This important finding needs critical evaluation if Libya is to improve its agricultural productivity and transform to organic farming practices. Road transportation and communication systems were also rather poor in many of the farms studied.

The farmers indicated that food-processing infrastructure to encourage the processing of excess produce is not readily available. Furthermore, the existing facilities are difficult to access. In addition, waste processing infrastructure that might help transform agricultural waste more efficiently into organic manure is not available at the farm level. These aspects do not make the transformation to organic farming attractive to farmers.

Venkatachalam (2003) states that the different types of infrastructures are complementary to each other and both essential and integral parts of economic development. Ashok *et al.* (2006) also argue that irrigation systems, roads, and markets are important infrastructural variables that influence total productivity. Thus insufficient processing, irrigation systems and access to water in the Libyan agricultural sector should be considered alongside other factors. In particular, other forms of infrastructure such as financial and extension services have a big influence on diversification and hence on the potential transformation to organic farming.

Following the evaluation of information on agricultural development, the research addressed the potential for the development of organic farming in Libya. The key factors identified in the potential development of organic farming as drivers or barriers were:

- Landlines and mobile telephone services;
- Inadequate distribution of internet infrastructure;
- Insufficient processing systems;
- Insufficient irrigation systems;
- Access to water;

- Electricity infrastructure;
- Road infrastructure;
- Financial services;
- Extension services; and
- Market development and validation.

As the research shows, agricultural infrastructure enhances the ability of farmers to use manure fertilizer and improved seeds, which are critical to the transformation to organic farming in Libya. However, the use of these inputs will be facilitated if agricultural processing infrastructure, irrigation systems and public access to water are more easily available to farmers at the local level.

It is concluded that the current infrastructure in Libya affects farming practices. The research shows that it may encourage or hinder transformation to organic farming practices, which may influence soil fertility and conservation with positive impacts for the environment. In the case of water, Karasov (1982) states that the greatest challenge for agriculture is to develop technology for improving water use efficiency. The research confirms that there is a poor distribution of water wells and drip irrigation systems in Libya, despite agriculture gaining a greater share of water resources. The problems of provision and of maintaining these systems do not assist with the transformation to organic farming practices. Such water systems are not available at the farm level where they are needed, and in most instances, even when they are available they are poorly maintained. It is argued in the literature that to enhance agricultural production, water must be of an adequate quality and quantity, and efficiently distributed. In the context of these issues, the interviews with expert stakeholders stressed the importance of agricultural infrastructure to future organic transformation. Governmental and other stakeholders in the agricultural sector noted that infrastructure has an important role in the development of agriculture in Libya. The implications on the ground were confirmed by the farmers.

The research concludes that farmers are dissatisfied with the current agricultural infrastructure availability and accessibility and have concerns with the standards of agricultural infrastructure such as irrigation, processing and road systems. Thus even if the supply of inputs such as fertilizers, insecticides, and seeds that are sometimes lacking is improved, the availability and accessibility of other infrastructure will need to be improved if farmers are to diversify and adapt. This is what might be anticipated from the literature review.

Access to agricultural loans by farmers is another area of concern that the research identified. The research argues that accessibility to agricultural loans on flexible payment terms including reduced interest rates and longer repayment periods will encourage farmers to diversify and perhaps adopt organic methods.

The establishment of agricultural banks in all agricultural regions could influence organic farming transformation. Farmers noted that a reduction in travel times to access banking services was considered especially important. The research data show that the control of agricultural banks by the government does not promote competition in the financing of agricultural activities. The banks are not sufficiently flexible with their products and the efficiency of their services does not encourage farmers to access credit to either improve their productivity or embrace new agricultural practices such as organic farming. Farmers are not given preference to credit facilities, even though the banks were originally set up to enhance agricultural activities. The literature notes that organic farmers in Africa face real challenges in relation to investment. The limited investment in infrastructure is attributed to the lack of access to investment financing and the limited interest from donors to support infrastructure development at the smallholder farmers level (Muwanga, 2010). The current situation in Libya in terms of agricultural financing is no different from the above finding.

The research concludes that agricultural banks in Libya should support the provision of infrastructure and enhance their services in providing loans on flexible terms to encourage farmers to transform to organic farming. The researcher suggests that the government should support farmers to motivate them to convert to organic farming, by adopting the Tunisia application to support farmers to transfer to organic farming, as Professor Kheder states:

> "*The government is supporting the farmers who have a desire to convert to the organic farming, by paying 20 to 30 % of the amount for the machinery and equipment which is used for this purpose. Furthermore, there encouraging motives every five years to the farmers who are involved in organic farming. In addition, the government is supervising the forms of surveillance and also provides training courses to farmers*" (Researcher interview, 2006*).*

The interviewee stated that the government support in Tunisia is between 20%-30% for farmers to buy machinery and equipment. In addition, he stated that the government support is significant in achieving organic farming goals. The means of support should therefore be of a reasonable amount, so as to encourage farmers to develop an organic farming philosophy which is based on their own belief in organic farming, and not by pushing them, and so an organic farming programme can be achieved.

Poor relations between farmers and agricultural research centres (ARCs) also hinder the transformation to organic farming. The research data indicates that farmers are not satisfied with the services of the ARCs. It appears there is no collaboration between the ARCs and farmers. In addition, the focus of agricultural research does not seem to benefit farmers since it does not affect their productivity. The research concludes that the activities of ARCs do not facilitate agricultural productivity in Libya. Even though there is high level of education among farmers, ARCs and extension services do not utilize this characteristic of farmers to enhance their productivity. Consequently, there is a low level of awareness among farmers on organic farming practices. The provision of support by agricultural research and extension services to farmers is currently not facilitating any transformation to organic farming in Libya. It appears that there is no effective coordination between agricultural research and extension services and farmers and are those services responsive to farmers' needs.

In addition, the availability of fixed and mobile telephone services is problematic. This undermines communication between ARCs, the various government agricultural institutions and farmers; thereby curtailing improvements in agricultural production. The availability of internet services, which is more important for the dissemination of data between the various government bodies and farmers, is more accessible in the regional capitals but most farms are located outside these areas. The extension of internet services to areas where farms are located would facilitate the sharing of information on new agricultural practices. This may take some time to accomplish but it is clear that the current spread of fixed and mobile telephone service does not help promote agricultural productivity or diversification.

It can be inferred from this research that although there are basic agricultural infrastructures in Libya, these need to be maintained and improved, in order to meet farmers' existing requirements and to facilitate any future transformation to organic farming. The current agricultural infrastructure in Libya has a number of positive characteristics and these could be harnessed to benefit farmers and enhance their desire to transform to organic farming. However, the research also identified weaknesses in the availability of agricultural infrastructure. These are related to the absence of modernization and a lack of planned improvements in the existing structures. Specifically, there are inefficiencies in a number of agricultural agencies and institutions, a shortage of processing facilities, inefficient distribution of inputs, a lack of training in modern agricultural practices, and inappropriate research and extension services. These weaknesses overshadow the efforts by the government in the promotion of agricultural activities and should be addressed in a holistic manner. Suggestions are made as to how these issues might be addressed.

## 8.2 Contribution of the Thesis to Knowledge and Understanding

This thesis enhances the body of knowledge relating to agricultural infrastructure by engaging with debates surrounding the concepts of agricultural infrastructure and diversification. It does this with particular respect to organic farming practices in Libya. The research provides a detailed case study of the issues relating to possible development of organic farming in an emerging Third World economy. This work contributes to a growing literature on these issues that largely overlooks Libya, and often has an emphasis on economically developed Western countries. The findings of the study provide insights that are transferable to other study regions and countries such as Tunisia, Morocco, and Algeria, Sudan. This research develops a novel approach to gathering information from an extensive sample of ordinary farmers in this emerging economy and samples their views alongside those of expert senior stakeholders. The outputs that result from the study will be of interest to a growing body of agricultural researchers in other Third World countries.

The thesis presents a number of key issues that relate to the promotion or hindrance to agricultural transformation. There is a relationship between agricultural infrastructure and farmers' practices and productivity. It is essential to understand this relationship and make it applicable to the context of Libya. In this regard, the availability of and accessibility to appropriate agricultural infrastructure including services are important to any future transformation to organic farming in Libya. Despite the fact that organic farming is in its embryonic stages in Libya, the research indicates that it may be possible to transform current agricultural practices. It is suggested that this would require the constraints associated with agricultural infrastructure, especially at the regional and farm levels, to be addressed. Central to this it seems that improvements in education and communication would be necessary. In addition, the development of better processing and transportation infrastructure could assist organic transformation, though these may also support agri-industrial approaches.

During the research a number of infrastructures that affect agricultural activities especially at the local level were identified. Along with a number of key agricultural services such as agricultural research and banking services these could be developed to facilitate the transformation to organic farming. It is making these agricultural infrastructures available and accessible especially at the farm level that can help to transform agricultural practices in Libya. If the development needs of farmers are met through provision of appropriate infrastructural support, a change to organic faming could begin. The result would be environmentally sound and also provide economic gains to farmers and to Libya.

This study contributes to an enhanced understanding of the critical issues in agricultural transformation by drawing attention to the barriers that impede the change to organic farming in Libya. Despite the potential advantages of adopting organic farming practices in Libya, this research indicates that such an approach is not without operational problems. Interviews with agricultural experts revealed that constraints arise in the planning and implementation of agricultural infrastructure policies in Libya. It is suggested that these are mostly bureaucratic issues that have political undertones.

The economic fortunes of organic farmers are tied to market availability. Matching the supply of organic produce to market demands is essential. Farmers need to be made aware of the challenges of the organic produce market such as strict certification requirements and be prepared through appropriate education and training programmes to meet these standards. The research indicates that access to markets is very important in the transformation to organic farming.

Availability of and accessibility to agricultural infrastructure are the most important variables in the transformation to organic farming in Libya. Both farmers and expert stakeholders perceive this as necessary for the development of agriculture in general. Collaboration between farmers and agricultural agencies is important to the provision of integrated infrastructure. This, in turn, can enhance the overall development of agriculture.

Many of the challenges to organic transformation in Libya can be overcome through the development of closer working relationships between farmers, researchers and agricultural agencies. Ultimately, increased communication and collaboration between all stakeholders in the agricultural sector is needed so that expectations can be met and concerns addressed.

Central to the relationships that need to emerge are linkages created by the synergies of processing infrastructure and market demand. These can effectively link agricultural activities to the national economy of, in this case, Libya. This would help sustain employment amongst the rural population that is not directly involved in the oil industry in Libya, and at the same time, ease environmental and health problems. This research shows that key agricultural infrastructure needs to be in place to enable any transformation to organic farming. Critical to this is the recognition by all stakeholders of the many benefits that organic farming provides. One of the most valuable contributions of the thesis is in emphasizing the importance of infrastructure availability and accessibility to the development of agriculture, both in general, and for organic farming in particular.

This study highlights the need for the phased development of organic farming in Libya. This would be through the setting up of demonstration farms in regions and districts that have relatively better agricultural infrastructure. It is noted that though it may be difficult to convince older farmers to convert, younger farmers with more education are more open to such changes. This could be encouraged through the provision of incentives to engage in organic farming.

The study has important implications for farmers, policy-makers, researchers, and regional agricultural agencies. The data suggest that much greater support and coordination, including financial assistance, is needed to facilitate and promote the organic transformation. The research shows that government has an important role to play in the education of farmers regarding the benefits of organic farming. This study supports other research that highlights the importance of improved agricultural infrastructure to the development of agriculture. The study emphasizes the need for increased promotion of organic farming and a more effective collaboration between agricultural sector stakeholders in the provision of agricultural infrastructure that meets the needs of farmers.

The main contribution of this study is that it provides for the first time, a detailed assessment of stakeholder views of agricultural infrastructure in Libya. It does this with a particular focus on the possibilities of a transformation to organic production systems. As such, the study provides a unique platform for future work in Libya and also an insight into stakeholder issues that is transferable to other countries.

## 8.3 Recommendations

After a critical in-depth evaluation and triangulation of the research data, recommendations are made on how the development of agricultural infrastructure can promote organic transformation in Libya. These recommendations are described below.

There should be closer collaboration amongst all stakeholders in the agricultural sector in order that the provision of agricultural infrastructure will be in the preferred areas to allow the maximum returns. This will require improved communication amongst stakeholders in the planning and implementation of agricultural policies.

The availability and accessibility of financial assistance to farmers should be structured to encourage farmers to undertake new farming practices such as organic farming. Financial assistance should be targeted to the delivery of selected policy outcomes. Aid should be more flexible in order to facilitate the transformation of willing farmers to organic farming. This could be achieved by making procedures easier for the farmers who apply for loans to expand their farming activities to include organic farming. The loans should be on long-term basis with low interest rates and the banks should consider the risk of transformation to organic farming since it is new to the country.

The research data supports the finding of Haring (2001), cited in the UK's Soil Association (2006:51) that "young farmers seem to increasingly favour organic farming...and the conversion to organic farming could be a reason for them to remain in farming instead of choosing other employment opportunities". Programmes and incentives aimed at the transformation to organic farming in Libya should give adequate consideration to younger farmers and incorporate their needs into agricultural strategic development plans.

Government should reform the management of agricultural research and extension services. It also needs to institutionalize consultation among agricultural stakeholders on performance-based strategic plans. These should be developed to enhance the transformation to organic farming in Libya. It is suggested that there will be little incentive for a transformation to organic farming until research, extension services, and farmer education are made more relevant to the needs of farmers. In order to more effectively address these matters, government needs to invest in an in-depth analysis of the key issues, including infrastructure and market development, and the provision of essential research support.

## 8.4 Further Research

Further research to extend this study on the importance of agricultural infrastructure in Libya is necessary to understand the relationships amongst various factors that affect agricultural development. This should involve interviews with farmers to tease out their real concerns with agricultural infrastructure in Libya. This will provide further detailed information on the importance and the type of agricultural infrastructure needed to establish organic farming. Research should attempt to discover why organic farming is not already a major part of the agricultural sector in Libya. Research is also needed to understand the motivational needs of younger farmers and how best to encourage them to practice organic farming.

The capacity of farmers to meet the standards on organic produce such as certification especially in European markets also warrants further investigation. Thought needs to be given to the education and training requirements of farmers so they may operate consistently and reliably in the organic market. The list of those to be surveyed in further research should include officials of agricultural research stations, principals of agricultural training schools, and representatives of farmers, agricultural sector representatives, policy-makers, and funding bodies. This could be followed up with semi-structured interviews specifically designed to provide a deeper understanding of the challenges that may be faced by group members.

This study considered three main sub-regions, each with its own characteristics in terms of agriculture, infrastructure and proximity to markets, etc. It would be informative to examine the sub-regions in more detail to draw out issues and perhaps critical differences that were not revealed in this study. Furthermore, it seems that the issues of drivers and barriers for transformation to organic farming might be different for commodities directed at export and those for internal consumption. This could be a productive direction for future research.

Similarly, the food production sector in Libya is a diverse field that ranges from meat and dairy, to grains, horticulture, and fruit. It would be worthwhile to address these sub-sectors to examine the opportunities for developing organic production systems.

In conclusion, this study's use of surveys and in-depth expert interviews has helped to bring understanding to the importance of agricultural infrastructure to the transformation to organic farming practices in Libya. It identified the characteristics of farmers and their experiences and factors that will motivate them to transform to organic farming. The interviews also revealed critical administrative and political constraints, which serve as impediments to agricultural development in Libya. The growing demand for quality organic produce, especially in Europe, and the proximity of Libya to Europe provides Libya with an opportunity. There is the potential to enhance organic farming development to create jobs and improve the financial status of its farmers. This thesis has demonstrated the value of agricultural infrastructure to enhance organic farming, which can contribute to the economic, environmental and social development of Libya. The potential role of organic farming should not be underestimated but instead should be nurtured by policy-makers and other industry stakeholders.

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## Appendix 1 Invitation for Interview-Farmers

Sheffield Hallam University

Dear Farmer

Peace and God's Blessing be upon you.

The researcher is undertaking a study on the importance of agricultural infrastructure to transformation to organic farming in Libya for a PhD research degree at Sheffield Hallam University in the UK. As a part of the research, the enclosed questionnaire is intended to collect some necessary information about agricultural infrastructure at the farm and the regional level and what its impact is on operating farming practices and activities.

I hope you will participate by completing the attached questionnaire. Kindly answer the questionnaire as you deem appropriate. All information and details you give will be treated as confidential and used for research purpose only. The researcher believes that your wide experience is significant to the successful outcome of this research.

Thank you in advance for your interest, contribution and cooperation.

Best Regards

Mostafa Wali Abdelwhab
Researcher

Appendix 2: Farmer Questionnaire

# QUESTIONNIRE ABOUT THE IMPORTANCE OF AGRICULTURAL INFRASTRUCTURE TO TRANSFORMATION TO ORGANIC FARMING.

## Section 1: General information about farmers and farms

1. Name: ..........................................

2. Age: 30-40 ☐ 41-51 ☐ 52-62☐ 63-73 ☐ 74+☐

3. Gender: Male ☐ Female ☐

4. Agricultural region: ALGABAL AKDER REGION ☐

ALJAFARA REGION ☐

FAZZAN REGION ☐

5. Experience/ Years: 10-15 ☐ 16-21☐ 22-27☐ 28-33☐

34 and above ☐

6. What level of education do you have?

Formal training ☐ Primary school ☐ Secondary school ☐

High school ☐ University ☐ Other ☐ .............

7. What is the type of your farm?

Dairy ☐ livestock ☐ horticulture ☐ mixed ☐

Other ☐ ..................

8. Farm size (in ha.): 5-15 ☐ 16-26☐ 27-37 ☐ 38-48 ☐

49-59☐ 60 and above ☐

9- Are you the : owner ☐ tenant ☐ other ☐ . .............

10. Are you responsible for farm decision making? Yes☐ No ☐

If no, who is responsible for farm decision making?

11. How many people manage this farm? 1-3 ☐ 4-6 ☐ 7-9 ☐ 10-12 ☐

12. How much is the annual turnover of your farm in Libyan Diners?

1000-5,999 ☐ 6000-11,999 ☐ 12000-17,999 ☐ 18000-23,999 ☐

24000-29,999 ☐ 30000-35,999 ☐ 36- 41,999 ☐ 42000-47,999 ☐

48000-53,999 ☐ 54000+ ☐

## Section2: AGRICULTURAL INFRASTRUCTURE AVAILABILITY

Please tick the appropriate box for the availability of the following infrastructure:

| | | Availability in Farm | Availability in Region |
|---|---|---|---|
| **Transportation:** | roads | ☐ | ☐ |
| **Communication:** | telephone | ☐ | ☐ |
| | fax | ☐ | ☐ |
| | mobil | ☐ | ☐ |
| | Internet | ☐ | ☐ |
| **Processing infrastructure:** | food processing | ☐ | ☐ |
| | waste re- processing | ☐ | ☐ |

**Irrigation and public access to water:**

- Source of Water:

| | | |
|---|---|---|
| well | ☐ | ☐ |
| rainfall | ☐ | ☐ |
| sanitation | ☐ | ☐ |
| re-used water | ☐ | ☐ |

- Irrigation system:

| | | |
|---|---|---|
| drip irrigation | ☐ | ☐ |
| Sprinkler irrigation | ☐ | ☐ |
| Conventional irrigation | ☐ | ☐ |

**Agricultural research and Extension services:**

| | |
|---|---|
| research centre | ☐ |
| training centre | ☐ |
| extension services | ☐ |

**Credit and financial institutions:**

| | |
|---|---|
| agricultural bank | ☐ |
| commercial bank | ☐ |

## Section Section 3: AGRICULTURAL INFRASTRUCTURE SATISTIFACTION

Please indicate how satisfied you are with the availability of the following:

| | | Satisfied | Neutral | Dissatisfied |
|---|---|---|---|---|
| **Transportation:** | roads | ☐ | ☐ | ☐ |
| **Communication:** | telephone | ☐ | ☐ | ☐ |
| | fax | ☐ | ☐ | ☐ |
| | mobil | ☐ | ☐ | ☐ |
| | Internet | ☐ | ☐ | ☐ |
| **Processing** | food processing | ☐ | ☐ | ☐ |
| **Infrastructure:** | waste processing | ☐ | ☐ | ☐ |
| **Irrigation and public access to water:** | | | | |
| - Source of Water: | | | | |
| | well | ☐ | ☐ | ☐ |
| | rainfall | ☐ | ☐ | ☐ |
| | sanitations | ☐ | ☐ | ☐ |
| | re-used water | ☐ | ☐ | ☐ |
| - Irrigation system: | | | | |
| | drip irrigation | ☐ | ☐ | ☐ |
| | sprinkler irrigation | ☐ | ☐ | ☐ |
| | conventional irrigation | ☐ | ☐ | ☐ |
| **Agricultural research and Extension services:** | | | | |
| | research centre | ☐ | ☐ | ☐ |
| | training centre | ☐ | ☐ | ☐ |
| | extension services | ☐ | ☐ | ☐ |
| **Credit and financial institutions:** | | | | |
| | agricultural bank | ☐ | ☐ | ☐ |
| | commercial bank | ☐ | ☐ | ☐ |

## Section3/1:AGRICULTURAL INFRASTRUCTURE ACCESSIBILITY

Please indicate how easy it is to access the following:

| | Easy | Neutral | Difficult | Don't know |
|---|---|---|---|---|
| **Transportation** | ☐ | ☐ | ☐ | ☐ |
| **Communication and information services** | ☐ | ☐ | ☐ | ☐ |
| **Processing infrastructure** | ☐ | ☐ | ☐ | ☐ |
| **Agricultural Research and Extension Services** | ☐ | ☐ | ☐ | ☐ |
| **Irrigation and Public access to water.** | ☐ | ☐ | ☐ | ☐ |
| **Credit and Financial Institution** | ☐ | ☐ | ☐ | ☐ |
| **Markets** | ☐ | ☐ | ☐ | ☐ |

**Section 4: Does the Transportation network to which you have access go to where it is needed?**

Yes ☐ No ☐

If not, please state why.........................................................................................................

...................................................................................................................................

**Section 5 : Is your choice of produce influenced by the available infrastructure?**

Please indicate by filling in (x) how the infrastructure influenced you to produce particular types of agricultural product:

| | Very strongly | Strongly | Natural | Weak | Not at all |
|---|---|---|---|---|---|
| Transportation | | | | | |
| Communication & information services | | | | | |
| Processing infrastructure | | | | | |
| Irrigation and public access to water | | | | | |
| Agricultural research and extension services | | | | | |
| Credit and financial institutions | | | | | |
| Markets | | | | | |

## Section 6: How important were the current infrastructures in the use of Agricultural inputs?

Please select one of the following options (Very important- important - not important)

by filling in the table :

Example (for fertilizer with transportation)

Very important = without transportation you can't reach market to buy fertilizer or use it.

Important = Transportation is necessary to encourage farmers to reach market to buy fertilizer.

Not important = you can reach the market to buy fertilizer without needing transportation and you use it.

| | Agricultural infrastructure | Very Important | Important | Not important |
|---|---|---|---|---|
| 1 | Transportation /Chemical fertilizer | | | |
| 2 | Transportation /Manure fertilizer | | | |
| 3 | Transportation /Seeds | | | |
| 4 | Transportation /Pesticides | | | |
| 5 | Transportation /Machinery & Equipment | | | |
| 6 | Communication/Chemical fertilizer | | | |
| 7 | Communication/Manure fertilizer | | | |
| 8 | Communication /Seeds | | | |
| 9 | Communication /Pesticides | | | |
| 10 | Communication /Machinery & Equipment | | | |
| 11 | Processing/Chemical fertilizer | | | |
| 12 | Processing/Manure fertilizer | | | |
| 13 | Processing /Seeds | | | |
| 14 | Processing /Pesticides | | | |
| 15 | Processing /Machinery & | | | |

| | | | | |
|---|---|---|---|---|
| | Equipment | | | |
| 16 | Irrigation and public access to water/Chemical fertilizer | | | |
| 17 | Irrigation and public access to water/Manure fertilizer | | | |
| 18 | Irrigation and public access to water /Seeds | | | |
| 19 | Irrigation and public access to water /Pesticides | | | |
| 20 | Irrigation and public access to water /Machinery & Equipment | | | |
| 21 | Credit and financial institutions/Chemical fertilizer | | | |
| 22 | Credit and financial institutions/Manure fertilizer | | | |
| 23 | Credit and financial institutions /Seeds | | | |
| 24 | Credit and financial institutions /Pesticides | | | |
| 25 | Credit and financial institutions /Machinery & Equipment | | | |
| 26 | Markets/Chemical fertilizer | | | |
| 27 | Markets/Manure fertilizer | | | |
| 28 | Markets /Seeds | | | |
| 29 | Markets /Pesticides | | | |
| 30 | Markets /Machinery & Equipment | | | |
| 31 | Agricultural research & extension services /Chemical fertilizer | | | |
| 32 | Agricultural research & extension services /Manure fertilizer | | | |
| 33 | Agricultural research & extension services /Seeds | | | |

| | | | | |
|---|---|---|---|---|
| 34 | Agricultural research & extension services /Pesticides | | | |
| 35 | Agricultural research & extension services /Machinery & Equipment | | | |

**Section 7: -In your opinion, do you think the currently available infrastructure enables you to address the following issues relating to the principles of organic farming?**

7-1 : Caring and long term maintenance of term soil fertility

Yes ☐ No ☐ Don't Know☐

If yes, how? :......................................................................................................

.............................................................................................................................

.............................................................................................................................

If no, why?...........................................................................................................

.............................................................................................................................

.............................................................................................................................

7- 2: Use of chemical fertilizer Yes☐ No☐ Don't Know ☐

If yes, how?..........................................................................................................

.............................................................................................................................

.............................................................................................................................

If no, why?............................................................................................................

.............................................................................................................................

.............................................................................................................................

7- 3- Use of manure fertilizer Yes☐ No☐ Don't Know ☐

If yes, how?.........................................................................................................

.............................................................................................................................

.............................................................................................................................

If no, why?............................................................................................................

..............................................................................................................................

..............................................................................................................................

7-4 : Following soil rotation Yes ☐ No ☐ Don't Know ☐

If yes, how?..........................................................................................................

..............................................................................................................................

..............................................................................................................................

If no, why?..........................................................................................................

..............................................................................................................................

..............................................................................................................................

7-5 : Use of biological combat Yes ☐ No ☐ Don't Know ☐

If yes, how?..........................................................................................................

..............................................................................................................................

If no, why?..........................................................................................................

..............................................................................................................................

..............................................................................................................................

**Section8 - How important were the current infrastructures in your decision to do the following:**

| | Extremely important | Very important | important | not at all |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| 8.1- To extend your area of agricultural land holding | ☐ | ☐ | ☐ | ☐ |
| 8.2- To produce a greater variety of crops | ☐ | ☐ | ☐ | ☐ |
| 8.3- To undertake all necessary agricultural practices | ☐ | ☐ | ☐ | ☐ |
| 8.4- To introduce new technology | | ☐ | ☐ | ☐ |
| 8,5- To introduce new agricultural methods | ☐ | ☐ | ☐ | ☐ |
| 8.6- To generate higher profit | ☐ | ☐ | ☐ | ☐ |

According to your experience what are the barriers you are facing with the infrastructure?

.............................................................................................................................

.............................................................................................................................

.............................................................................................................................

.............................................................................................................................

Would you like to participate in future studies and if so, would you mind us contacting you for further clarification?

Telephone:.................................................

Thank you very much for your time and effort. The results will help us to have a better understanding of the importance of agricultural infrastructure and how it plays an important role in the transformation to an organic farming system. We will use this information to make recommendations to the policy makers for improving the agricultural sector in this country.

## Appendix 3 Invitation for Interview-Agricultural Experts

Sheffield
Hallam University

Dear Sir/ Madam

Peace and God's Blessing be upon you.

The researcher is undertaking a study on the importance of agricultural infrastructure to transformation to organic farming in Libya for a PhD research degree at Sheffield Hallam University in the UK. As a part of the research, I would like to conduct an interview with you as an expert in the agricultural sector to collect some necessary information about the agricultural infrastructure at the farm and regional level and how it impacts on operating farming practices and activities.

You are assured that all information and details you give will be treated as confidential and used for research purpose only. The researcher believes that your wide experience is significant to the successful outcome of this research.

Thank you in advance for your interest, contribution and cooperation.

Best Regards

Mostafa Wali Abdelwhab

Researcher

## Appendix 4: Interview Questions

Q1. What is the role of general infrastructure in the development and growth of the agricultural sector?

Q2. What is your assessment for the present agricultural sector in the Jamahiriya, in respect of quality, capacity and efficiency of agricultural activities?

Q3. To what extent do you believe the farmers are satisfied with the standard and effectiveness of the agricultural infrastructure?

Q4. Do you believe the agriculture sector has adequate mechanisms to receive and handle farmers' complaints regarding agricultural infrastructures?

Q5. How do you measure the extent of farmers' satisfaction in respect of the standard and effectiveness of the agricultural infrastructure in the Jamahiriya?

Q6. In view of your practical experience, do you think that the introduction of new technologies reflect the state of the present agricultural infrastructure? Is the introduction of modern technology a requirement at present?

Q7.What are the aspects of strength and weakness in the present agricultural infrastructure in the Jamahiriya?

Q8. What are the prospects for the optimum exploitation and modernization of the agricultural infrastructure?

Q9. To what extent do you think the actual financing of the agricultural infrastructure would contribute towards the development of the agricultural sector?

Q10. Do you think that the Agricultural Bank is performing a major role in financing the activities related to the infrastructure of the agricultural sector?

Q11. Does the Agricultural Bank depend on its funding for the agricultural infrastructure on the plans and proposals laid down by the GPC for agriculture? To what extent does this lead to the improvement and development of the sector?

Q12. Are there any plans related to the issue of organic agriculture? Do you believe there is a possibility of doing so?

## Appendix 5: Sample of Transcribed Interview

Q1. What is the role of general infrastructure in the development and growth of the agricultural sector?

1- Interviewee A

Yes, the role is important. The basic agricultural infrastructure that existed in Libya had a major role in making a significant shift in farming. The availability of electricity, roads, farming settlements, industries and communications had a great impact in the enlargement of agricultural areas.

Other forms of infrastructure also played a crucial role; such as the Agricultural Bank, the Agricultural Research Centre, agricultural information and guidance, all these facilities contributed to the increase of production.

For example, the production of cereals grew significantly. The production of corn increased from 1.5 tonne per hectare to 6.5 – 7 tonne per hectare, and then to 9.5 per hectare. This demonstrates the role of general infrastructure in developing the agricultural sector in our country.

2- Interviewee B

The general infrastructure plays a major role in the development and growth of the agricultural sector in Libya. This role was clear when roads, electricity and agricultural facilities led to the introduction of agricultural machinery in various areas. The more roads we have, the more supplies of seeds and fertilizers become available.

The introduction of new technologies in agricultural areas, such as in Fezzan, contributed to the better utilization of water and soil, which led to a huge increase in productivity.

3- Interviewee C

The agricultural infrastructure built during the first plans and the introduction of agricultural facilities during the1970's has significantly contributed towards the development and growth of the agricultural sector. Roads and other services have facilitated work in the agricultural sector at local and national levels. For example, various road networks between south and north meant the success of cereal production projects in the south of the Jamahiriya. These roads meant easy transport of machinery, fertilizers, as well as transport and marketing. Generally, the infrastructure played a significant role in the development of the agricultural sector. It also meant the continued policy of securing local food production, which consolidates food security policies.

4- Interviewee D

The present agricultural infrastructure played a major role in the development of the agricultural sector generally. That was quite clear in the increase of production. When we compare the 1960's with 1990's and the present time, we note the huge increase and growth of agricultural areas. The availability of the infrastructure in itself has encouraged the tendency for investment in the agricultural sector. As a result of the role played by the agricultural infrastructure, there was a substantial increase in employment in the agricultural sector. It is worth noting that the agricultural sector in Libya has achieved great successes as a result of the development of the agricultural infrastructure. That was also consolidated by the policies aiming at the development of agricultural investment.

5- Interviewee E

The agricultural infrastructure now present has greatly contributed towards the provision of a large part of the Jamahiriya requirements for agricultural production. It is helping in the horizontal and vertical growth of agriculture, and training qualified cadres in the agriculture sector. That also defines the resources suitable for agricultural development. The availability of agricultural facilities helped in reducing any waste in the production, through storage and industrialization. Generally, the role played by agricultural infrastructure may be summarized in providing all our food requirements, the training of technical cadres in the agricultural sector, the education of farmers and the increase of production as well as the diversity of cereals, the introduction of new technologies and new systems. All that would lead to the general increase of agricultural products and the increase of general local production.

6- Interviewee F

Through my experience in the agricultural sector, I could confirm that the agricultural infrastructure is the basis for all development in the agricultural and economic sectors. As a result of diversification and growth of agriculture, at local and national levels, this has led to an increase in the agricultural areas. For example, had it not been for the new agricultural lands claimed, we would not have been able to increase production of cereals and fodders in commercial at a commercial scale. Our production could neither have access to the markets. The infrastructure helped in the introduction of farming machinery in these areas, deep in the desert. That also helped in the provision of various production tools and requirements, such as seeds, fertilizers and insecticides. Furthermore, that increased the agricultural areas and diversified cereal production. Had it not been for the introduction of new irrigation technologies, we could not have achieved a sustained development and growth in agriculture.

7- Interviewee G

The present agricultural infrastructure has greatly contributed in the development and growth of the agricultural sector in the Jamahiriya. Through our work in the Agricultural Bank, which is a major pillar supporting agriculture and general economy, we note that our direct involvement with farmers has great impacts in the development of the agricultural sector.

The present infrastructure made it possible for the agricultural sector to grow. We have also noted the increased share of agriculture in the General Domestic Income. That led many people to focus on agriculture and the establishment of farms financed by the Bank. This tendency had been consolidated by the Bank as well as by the general policies. However, the agricultural infrastructure is the major factor in encouraging the people to establish farms and various other agricultural projects. The Bank played a major role in developing the agricultural systems and the growth of farming areas.

The Bank contributed in financing and the establishment of various projects totalling 7377 project, with a total value of 507 million Libyan dinar. The number of those who have directly profited from these projects total 9131 people.

Furthermore, the agricultural infrastructure contributed in the increase of farmer's profits and the facilitation of various other agricultural operations, thanks to the availability of markets, roads, communications, etc. There has been a huge increase in production as well as diversification, as new crops were introduced.

8- Interviewee H

When the state, or in fact the general policy of the state, began to think about the diversification of income resources, out of the oil sector, and to develop Libyan economy during the 1970's, the normal tendency was to go for agriculture, as Libya has vast areas of land suitable for agriculture. That area is more than 2 million hectare. Therefore, the state allocated millions of dinars to establish the general infrastructure for development generally and for agriculture in particular. That required the building of roads, for agriculture and industries related to the agricultural and food production. That, in turn, made it necessary to introduce new irrigation systems and digging water wells. There was also need to establish banking facilities, such as the Agricultural Bank. All that helped greatly in making real change, in respect of the general agricultural production at local and national levels. A large number of people were also employed or worked for themselves in agricultural projects and related industries. We were also able to export the excess production to regional or international markets.

Furthermore, we thought of introducing new farming activities, such as the production of bananas, apples, and various cereals. Animal wealth projects were also introduced, particularly those for livestock, poultry and dairy production. There was a huge increase in agricultural areas, including some lands that seemed impossible to claim previously. Now these lands generate a constant source of income for thousands. Therefore, it is worth noting that agricultural infrastructures in Libya contributed greatly in developing the Libyan agricultural sector.

9- Interviewee I

The present agricultural infrastructure led to the development of the agricultural sector and the modernization of the sector to rival developed agriculture worldwide. The horizontal and vertical development across the Jamahiriya meant the increase of agricultural activity in all suitable lands. Furthermore, the roads built, communications, markets, research centres, agricultural institutes, wells and the Great Man-made River, all that led to a huge increase in agricultural activities and the increased production. The agricultural sector has thus greatly contributed in the increase of the general domestic income. This increase is evident from 1970's and up to present. There is also substantial increase in human power and employment in the agricultural sector and related industries. The sector has become attractive and many people are encouraged to enter it.

All those achievements were made possible thanks to the agricultural infrastructure that was established. Such infrastructure played a great role in the development of the sector. The details of such developments could be shown in detail by the statistics and data, which prove a dramatic change from the 1970's and later on up to the present time.

## Appendix 6: Quantitative Analysis

**Section 1: STATSTICAL DISTRIBUTION ANAYLISIS**

1. Distribution of Farmers and Farms Information

1,1 Agricultural Regions

**Table 5.1 AGRICULTURAL REGIONS**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | AL-GABAL AL-AKDER | 99 | 35.7 | 35.7 | 35.7 |
| | ALJAFARA | 83 | 30.0 | 30.0 | 65.7 |
| | FAZZAN | 95 | 34.3 | 34.3 | 100.0 |
| | Total | 277 | 100.0 | 100.0 | |

1.2 Farmer's Age

**Table 5 .3 Age of Farmers of respondents**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | 30-40 | 38 | 13.7 | 16.5 | 16.5 |
| | 41-51 | 66 | 23.8 | 28.7 | 45.2 |
| | 52-62 | 60 | 21.7 | 26.1 | 71.3 |
| | 63-73 | 49 | 17.7 | 21.3 | 92.6 |
| | 74+ | 17 | 6.1 | 7.4 | 100.0 |
| | Total | 230 | 83.0 | 100.0 | |
| Missing | -99.00 | 47 | 17.0 | | |
| Total | | 277 | 100.0 | | |

1.3 Farmer's Level of Education

**Table 5 .4 LEVEL OF EDUCATION**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | FORMAL TRAINING | 48 | 17.3 | 17.5 | 17.5 |
| | PRIMARY SCHOOL | 37 | 13.4 | 13.5 | 31.0 |
| | SECONDARY SCHOOL | 44 | 15.9 | 16.1 | 47.1 |
| | HIGH SCHOOL | 64 | 23.1 | 23.4 | 70.4 |
| | UNIVERSITY | 66 | 23.8 | 24.1 | 94.5 |
| | OTHER | 15 | 5.4 | 5.5 | 100.0 |
| | Total | 274 | 98.9 | 100.0 | |
| Missing | -99.00 | 3 | 1.1 | | |
| Total | | 277 | 100.0 | | |

1,4 Farmer's Experience

**Table 5 .5 Farmer's EXPERIENCE**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | 10-15 | 71 | 25.6 | 25.6 | 25.6 |
| | 16-21 | 51 | 18.4 | 18.4 | 44.0 |
| | 22-27 | 65 | 23.5 | 23.5 | 67.5 |
| | 28-33 | 50 | 18.1 | 18.1 | 85.6 |
| | 34+ | 40 | 14.4 | 14.4 | 100.0 |
| | Total | 277 | 100.0 | 100.0 | |

1.5 Farm"s Size

**Table 5 .6 FARM SIZE**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | 5-15 | 145 | 52.3 | 54.7 | 54.7 |
| | 16-26 | 76 | 27.4 | 28.7 | 83.4 |
| | 27-37 | 22 | 7.9 | 8.3 | 91.7 |
| | 38-48 | 11 | 4.0 | 4.2 | 95.8 |
| | 49-59 | 3 | 1.1 | 1.1 | 97.0 |
| | 60+ | 8 | 2.9 | 3.0 | 100.0 |
| | Total | 265 | 95.7 | 100.0 | |
| Missing | -99.00 | 12 | 4.3 | | |
| Total | | 277 | 100.0 | | |

1.6 Farm's Type

**Table 5 .7 FARM TYPE**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | DAIRY | 1 | .4 | .4 | .4 |
| | LIVESTOCK | 11 | 4.0 | 4.0 | 4.4 |
| | HORTICULTURE | 86 | 31.0 | 31.5 | 35.9 |
| | MIXED | 171 | 61.7 | 62.6 | 98.5 |
| | OTHER | 4 | 1.4 | 1.5 | 100.0 |
| | Total | 273 | 98.6 | 100.0 | |
| Missing | -99.00 | 4 | 1.4 | | |
| Total | | 277 | 100.0 | | |

## 1.7 Farm's Ownership

**Table 5 .8 OWNERSHIP**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | OWNER | 224 | 80.9 | 82.7 | 82.7 |
| | TENANT | 4 | 1.4 | 1.5 | 84.1 |
| | OTHER | 43 | 15.5 | 15.9 | 100.0 |
| | Total | 271 | 97.8 | 100.0 | |
| Missing | -99.00 | 6 | 2.2 | | |
| Total | | 277 | 100.0 | | |

## 1.8 Farms Responsibility for Decision Making

**Table 5.9 RESPONSIBILITY FOR DECISION MAKING**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | YES | 261 | 94.2 | 96.0 | 96.0 |
| | NO | 11 | 4.0 | 4.0 | 100.0 |
| | Total | 272 | 98.2 | 100.0 | |
| Missing | -99.00 | 5 | 1.8 | | |
| Total | | 277 | 100.0 | | |

## 1.9 How Many People Manage the farm

**Table 5.10 HOW MANY PEOPLE MANAGE THE FARM**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | 1-3 | 146 | 52.7 | 68.2 | 68.2 |
| | 4-6 | 53 | 19.1 | 24.8 | 93.0 |
| | 7-9 | 11 | 4.0 | 5.1 | 98.1 |
| | 10-12 | 4 | 1.4 | 1.9 | 100.0 |
| | Total | 214 | 77.3 | 100.0 | |
| Missing | -99.00 | 63 | 22.7 | | |
| Total | | 277 | 100.0 | | |

## 2. STATSTICAL DISTRIBUTION OF AGRICULTURAL INFRASTRUCTURE AVALIABLITY

**Statistics**

| | | TRANSPORTATION-ROADS | COMMUNICATION-TELEPHONE | COMMUNICATION-MOBILE | COMMUNICATION-FAX | COMMUNICATION-INTERNET |
|---|---|---|---|---|---|---|
| N | Valid | 272 | 185 | 232 | 23 | 40 |
| | Missing | 5 | 92 | 45 | 254 | 237 |

### 2.1 Transportation Roads

**TRANSPORTATION-ROADS**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | FARM AVAILABILITY | 10 | 3.6 | 3.7 | 3.7 |
| | REGIONAL AVAILABIULITY | 262 | 94.6 | 96.3 | 100.0 |
| | Total | 272 | 98.2 | 100.0 | |
| Missing | -99.000 | 5 | 1.8 | | |
| Total | | 277 | 100.0 | | |

### 2.2 Communication and Information services

#### 2.2.1 Telephone

**COMMUNICATION-TELEPHONE**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | FARM AVAILABILITY | 121 | 43.7 | 65.4 | 65.4 |
| | REGIONAL AVAILABIULITY | 64 | 23.1 | 34.6 | 100.0 |
| | Total | 185 | 66.8 | 100.0 | |
| Missing | -99.00 | 92 | 33.2 | | |
| Total | | 277 | 100.0 | | |

### 2.2.2 Mobil

**COMMUNICATION-MOBILE**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | FARM AVAILABILITY | 209 | 75.5 | 90.1 | 90.1 |
| | REGIONAL AVAILABIULITY | 23 | 8.3 | 9.9 | 100.0 |
| | Total | 232 | 83.8 | 100.0 | |
| Missing | -99.00 | 45 | 16.2 | | |
| Total | | 277 | 100.0 | | |

### 2.2.3 Fax

**COMMUNICATION-FAX**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | FARM AVAILABILITY | 2 | .7 | 8.7 | 8.7 |
| | REGIONAL AVAILABIULITY | 21 | 7.6 | 91.3 | 100.0 |
| | Total | 23 | 8.3 | 100.0 | |
| Missing | -99.00 | 254 | 91.7 | | |
| Total | | 277 | 100.0 | | |

### 2.2.4 Internet

**COMMUNICATION-INTERNET**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | FARM AVAILABILITY | 18 | 6.5 | 45.0 | 45.0 |
| | REGIONAL AVAILABIULITY | 22 | 7.9 | 55.0 | 100.0 |
| | Total | 40 | 14.4 | 100.0 | |
| Missing | -99.00 | 237 | 85.6 | | |
| Total | | 277 | 100.0 | | |

## 2.3 Processing Infrastructure

**Statistics**

| | | PROCESSING INFRASTRUCTURE-FOOD | PROCESSING INFRASTRUCTURE-WASTE | SOURCE OF WATER-WELL | SOURCE OF WATER-RAINFALL | SOURCE WATER-RE-USED WATER | IRRIGATION SYSTEM-DROP | IRREGATION SYSTEM - SPRINKLER | IRREGATION SYSTEM-CONVENTIONAL |
|---|---|---|---|---|---|---|---|---|---|
| N | Valid | 45 | 28 | 262 | 127 | 22 | 128 | 190 | 122 |
| | Missing | 232 | 249 | 15 | 150 | 255 | 149 | 87 | 155 |

### 2.3.1 Processing Food Infrastructure

**PROCESSING INFRASTRUCTURE-FOOD**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | FARM AVAILABILITY | 2 | .7 | 4.4 | 4.4 |
| | REGIONAL AVAILABIULITY | 43 | 15.5 | 95.6 | 100.0 |
| | Total | 45 | 16.2 | 100.0 | |
| Missing | -99.00 | 232 | 83.8 | | |
| Total | | 277 | 100.0 | | |

## 2.3.2 Processing Waste Infrastructure

**PROCESSING INFRASTRUCTURE-WASTE**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | FARM AVAILABILITY | 2 | .7 | 7.1 | 7.1 |
| | REGIONAL AVAILABIULITY | 26 | 9.4 | 92.9 | 100.0 |
| | Total | 28 | 10.1 | 100.0 | |
| Missing | -99.00 | 249 | 89.9 | | |
| | | 277 | 100.0 | | |

## 2.4.1.1 Wells

**SOU**

| | | | | | |
|---|---|---|---|---|---|
| Valid | FARM AVAILABILITY | | | | |
| | REGIONAL AVAILABIULITY | | | | |
| | Total | | | | |
| Missing | -99.00 | | | | |
| Total | | | | | |
| Total | | | | | |

## 2.4 Irrigation and Public access to water

### 2.4.1 Source of water

#### 2.4.1.2Rainfall

**SOURCE OF WATER-RAINFALL**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | FARM AVAILABILITY | 101 | 36.5 | 79.5 | 79.5 |
| | REGIONAL AVAILABIULITY | 26 | 9.4 | 20.5 | 100.0 |
| | Total | 127 | 45.8 | 100.0 | |
| Missing | -99.00 | 150 | 54.2 | | |
| Total | | 277 | 100.0 | | |

#### 2.4.1.3 Re-used water

**SOURCE WATER-RE-USED WATER**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | FARM AVAILABILITY | 5 | 1.8 | 22.7 | 22.7 |
| | REGIONAL AVAILABIULITY | 17 | 6.1 | 77.3 | 100.0 |
| | Total | 22 | 7.9 | 100.0 | |
| Missing | -99.00 | 255 | 92.1 | | |
| Total | | 277 | 100.0 | | |

.2.4.2 Irrigation System

2.4. 2.1 Drip Irrigation System

**IRRIGATION SYSTEM-DROP**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | FARM AVAILABILITY | 114 | 41.2 | 89.1 | 89.1 |
| | REGIONAL AVAILABIULITY | 14 | 5.1 | 10.9 | 100.0 |
| | Total | 128 | 46.2 | 100.0 | |
| Missing | -99.00 | 149 | 53.8 | | |
| Total | | 277 | 100.0 | | |

2.4.2.2. Sprinkler Irrigation System

**IRREGATION SYSTEM-SPRINKLER**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | FARM AVAILABILITY | 167 | 60.3 | 87.9 | 87.9 |
| | REGIONAL AVAILABIULITY | 23 | 8.3 | 12.1 | 100.0 |
| | Total | 190 | 68.6 | 100.0 | |
| Missing | -99.00 | 87 | 31.4 | | |
| Total | | 277 | 100.0 | | |

2.4.2.3 Conventional Irrigation System

**IRREGATION SYSTEM-CONVENTIONAL**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | FARM AVAILABILITY | 109 | 39.4 | 89.3 | 89.3 |
| | REGIONAL AVAILABIULITY | 13 | 4.7 | 10.7 | 100.0 |
| | Total | 122 | 44.0 | 100.0 | |
| Missing | -99.00 | 155 | 56.0 | | |
| Total | | 277 | 100.0 | | |

## 2.5 Agricultural Research and Extension services

**Statistics**

| | RESEARCH AND EXTENSION-RESEARCH CENTRE | IRREGATION SYSTEM-CONVENTIONAL | RESEARCH AND EXTENSION-TRAINING CENTRE | RESEARCH AND EXTENSION-EXTENSION SERVICES | CREDIT AND FINANCIAL INSTITUTION-AGRICULTURAL BANK | CREDIT AND FINANCIAL INSTITUTION-COMMERCIAL BANK | CREDIT AND FINANCIAL INSTITUTION-ANOTHER BANK |
|---|---|---|---|---|---|---|---|
| N Valid | 65 | 122 | 29 | 160 | 203 | 76 | 36 |
| Missing | 212 | 155 | 248 | 117 | 74 | 201 | 241 |

### 2.5.1 Agricultural Research Centre

**AGRICULTURAL RESEARCH AND EXTENSION-RESEARCH CENTRE**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | REGIONAL AVAILABIULITY | 65 | 23.5 | 100.0 | 100.0 |
| Missing | -99.00 | 212 | 76.5 | | |
| Total | | 277 | 100.0 | | |

### 2.5.2 Training Centre

**RESEARCH AND EXTENSION-TRAINING CENTRE**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | REGIONAL AVAILABIULITY | 29 | 10.5 | 100.0 | 100.0 |
| Missing | -99.00 | 248 | 89.5 | | |
| Total | | 277 | 100.0 | | |

### 2.5.3 Extension Services

**RESEARCH AND EXTENSION-EXTENSION SERVICES**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | REGIONAL AVAILABIULITY | 160 | 57.8 | 100.0 | 100.0 |
| Missing | -99.00 | 117 | 42.2 | | |
| Total | | 277 | 100.0 | | |

## 2.6 Credit and Financial Institution

### 2.6.1 Agricultural Banks

**CREDIT AND FINANCIAL INSTITUTION-AGRICULTURAL BANK**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | REGIONAL AVAILABIULITY | 203 | 73.3 | 100.0 | 100.0 |
| Missing | -99.00 | 73 | 26.4 | | |
| | System | 1 | .4 | | |
| | Total | 74 | 26.7 | | |
| Total | | 277 | 100.0 | | |

### 2.6.2 Commercial Banks

**CREDIT AND FINANCIAL INSTITUTION-COMMERCIAL BANK**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | REGIONAL AVAILABIULITY | 76 | 27.4 | 100.0 | 100.0 |
| Missing | -99.00 | 201 | 72.6 | | |
| Total | | 277 | 100.0 | | |

## 3. STATSTICAL DISTRIBUTION OF AGRICULTURAL INFRASTRUCTURE ACCESSIBILITY

**Statistics**

| | | TRANSPORATION ACCESSIBILITY | COMMUNICATION AND INFORMATION ACCESSIBILITY | PROCESSING ACCESSIBLITY | AGRICULTURAL RESEARCH AND EXTENSION ACCESSIBILITY | IRRIGATION AND PUBLIC ACCESS TO WATER ACCESSIBILITY | CREDIT AND FINANCIAL INSTITUTION ACCESSIBILITY | MARKETS ACCESSIBILITY |
|---|---|---|---|---|---|---|---|---|
| N | Valid | 275 | 267 | 215 | 242 | 270 | 259 | 262 |
| | Missing | 2 | 10 | 62 | 35 | 7 | 18 | 15 |

## 3.1 Transportation Accessibility

**TRANSPORATION ACCESSIBILITY**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | EASY | 97 | 35.0 | 35.3 | 35.3 |
| | NEUTRAL | 107 | 38.6 | 38.9 | 74.2 |
| | DIFFICULT | 69 | 24.9 | 25.1 | 99.3 |
| | DON'T KNOW | 2 | .7 | .7 | 100.0 |
| | Total | 275 | 99.3 | 100.0 | |
| Missing | -99.00 | 2 | .7 | | |
| Total | | 277 | 100.0 | | |

## 3.2 Communication and Information Services Accessibility

**COMMUNICATION AND INFORMATION ACCESSIBILITY**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | EASY | 98 | 35.4 | 36.7 | 36.7 |
| | NEUTRAL | 104 | 37.5 | 39.0 | 75.7 |
| | DIFFICULT | 54 | 19.5 | 20.2 | 95.9 |
| | DON'T KNOW | 11 | 4.0 | 4.1 | 100.0 |
| | Total | 267 | 96.4 | 100.0 | |
| Missing | -99.00 | 8 | 2.9 | | |
| | System | 2 | .7 | | |
| | Total | 10 | 3.6 | | |
| Total | | 277 | 100.0 | | |

## 3.3 Processing Infrastructure Accessibility

**PROCESSING ACCESSIBLITY**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | EASY | 4 | 1.4 | 1.9 | 1.9 |
| | NEUTRAL | 13 | 4.7 | 6.0 | 7.9 |
| | DIFFICULT | 99 | 35.7 | 46.0 | 54.0 |
| | DON'T KNOW | 99 | 35.7 | 46.0 | 100.0 |
| | Total | 215 | 77.6 | 100.0 | |
| Missing | -99.00 | 60 | 21.7 | | |
| | System | 2 | .7 | | |
| | Total | 62 | 22.4 | | |
| Total | | 277 | 100.0 | | |

## 3.4 Agricultural Research and Extension Services Accessibility

**AGRICULTURAL RESEARCH AND EXTENSION ACCESSIBILITY**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | EASY | 7 | 2.5 | 2.9 | 2.9 |
| | NEUTRAL | 29 | 10.5 | 12.0 | 14.9 |
| | DIFFICULT | 145 | 52.3 | 59.9 | 74.8 |
| | DON'T KNOW | 61 | 22.0 | 25.2 | 100.0 |
| | Total | 242 | 87.4 | 100.0 | |
| Missing | -99.00 | 34 | 12.3 | | |
| | System | 1 | .4 | | |
| | Total | 35 | 12.6 | | |
| Total | | 277 | 100.0 | | |

## 3.5 Irrigation and Public access to Water Accessibility

**IRRIGATION AND PUBLIC ACCESS TO WATER ACCESSIBILITY**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | EASY | 52 | 18.8 | 19.3 | 19.3 |
| | NEUTRAL | 114 | 41.2 | 42.2 | 61.5 |
| | DIFFICULT | 101 | 36.5 | 37.4 | 98.9 |
| | DON'T KNOW | 3 | 1.1 | 1.1 | 100.0 |
| | Total | 270 | 97.5 | 100.0 | |
| Missing | -99.00 | 7 | 2.5 | | |
| Total | | 277 | 100.0 | | |

## 3.6 Credit and Financial Institution Accessibility

**CREDIT AND FINANCIAL INSTITUTION ACCESSIBILITY**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | EASY | 19 | 6.9 | 7.3 | 7.3 |
| | NEUTRAL | 71 | 25.6 | 27.4 | 34.7 |
| | DIFFICULT | 147 | 53.1 | 56.8 | 91.5 |
| | DON'T KNOW | 22 | 7.9 | 8.5 | 100.0 |
| | Total | 259 | 93.5 | 100.0 | |
| Missing | -99.00 | 18 | 6.5 | | |
| Total | | 277 | 100.0 | | |

## 3.7 Markets Accessibility

**MARKETS ACCESSIBILITY**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | EASY | 51 | 18.4 | 19.5 | 19.5 |
| | NEUTRAL | 109 | 39.4 | 41.6 | 61.1 |
| | DIFFICULT | 95 | 34.3 | 36.3 | 97.3 |
| | DON'T KNOW | 7 | 2.5 | 2.7 | 100.0 |
| | Total | 262 | 94.6 | 100.0 | |
| Missing | -99.00 | 15 | 5.4 | | |
| Total | | 277 | 100.0 | | |

## 4. STATSITCAL DISTRUBUTION OF FARMERS SATSIFACTION WITH CURRENT AGRICULTURAL INFRASTRUCTURE

**Statistics**

| | | TRANSPORTATION-ROADS | COMMUNICATION-TELEPHONE | COMMUNICATION-FAX | COMMUNICATION-MOBILE | COMMUNICATION-INTERNET |
|---|---|---|---|---|---|---|
| N | Valid | 273 | 193 | 29 | 222 | 51 |
| | Missing | 4 | 84 | 248 | 55 | 226 |

4.1 Transportation Roads

**TRANSPORTATION-ROADS**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | SATISFIED | 123 | 44.4 | 45.1 | 45.1 |
| | NEUTRAL | 74 | 26.7 | 27.1 | 72.2 |
| | DISSATISFIED | 76 | 27.4 | 27.8 | 100.0 |
| | Total | 273 | 98.6 | 100.0 | |
| Missing | -99.00 | 4 | 1.4 | | |
| Total | | 277 | 100.0 | | |

4.2 Communication and Information Services

4.2.1 Telephone Communication

**COMMUNICATION-TELEPHONE**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | SATISFIED | 117 | 42.2 | 60.6 | 60.6 |
| | NEUTRAL | 43 | 15.5 | 22.3 | 82.9 |
| | DISSATISFIED | 33 | 11.9 | 17.1 | 100.0 |
| | Total | 193 | 69.7 | 100.0 | |
| Missing | -99.00 | 84 | 30.3 | | |
| Total | | 277 | 100.0 | | |

4.2.2 Fax Communication

**COMMUNICATION-FAX**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | SATISFIED | 12 | 4.3 | 41.4 | 41.4 |
| | NEUTRAL | 3 | 1.1 | 10.3 | 51.7 |
| | DISSATISFIED | 14 | 5.1 | 48.3 | 100.0 |
| | Total | 29 | 10.5 | 100.0 | |
| Missing | -99.00 | 248 | 89.5 | | |
| Total | | 277 | 100.0 | | |

4.2.3 Mobil Communication

**COMMUNICATION-MOBILE**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | SATISFIED | 157 | 56.7 | 70.7 | 70.7 |
| | NEUTRAL | 48 | 17.3 | 21.6 | 92.3 |
| | DISSATISFIED | 17 | 6.1 | 7.7 | 100.0 |
| | Total | 222 | 80.1 | 100.0 | |
| Missing | -99.00 | 55 | 19.9 | | |
| Total | | 277 | 100.0 | | |

4.2.4 Internet Communication

**COMMUNICATION-INTERNET**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | SATISFIED | 21 | 7.6 | 41.2 | 41.2 |
| | NEUTRAL | 19 | 6.9 | 37.3 | 78.4 |
| | DISSATISFIED | 11 | 4.0 | 21.6 | 100.0 |
| | Total | 51 | 18.4 | 100.0 | |
| Missing | -99.00 | 226 | 81.6 | | |
| Total | | 277 | 100.0 | | |

## 4.3 Processing Infrastructure

**Statistics**

| | | PROCESSING INFRASTRUCTURE-FOOD | PROCESSING INFRASTRUCTURE-WASTE | IRRIGATION/ACCESS TO WATER-WELL | IRRIGATION/ACCESS TO WATER-RAINFALL | IRRIGATION/ACCESS TO WATER-SANITATION | IRRIGATION/ACCESS TO WATER-RE-USED WATER | IRRIGATION SYSTEM-DROP | IRREGATION SYSTEM-SPRINKLER | IRREGATION SYSTEM-CONVENTIONAL |
|---|---|---|---|---|---|---|---|---|---|---|
| N | Valid | 113 | 99 | 266 | 131 | 89 | 65 | 139 | 177 | 127 |
| | Missing | 164 | 178 | 11 | 146 | 188 | 212 | 138 | 100 | 150 |

### 4.3.1 Food Processing Infrastructure

**PROCESSING INFRASTRUCTURE-FOOD**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | SATISFIED | 5 | 1.8 | 4.4 | 4.4 |
| | NEUTRAL | 11 | 4.0 | 9.7 | 14.2 |
| | DISSATISFIED | 97 | 35.0 | 85.8 | 100.0 |
| | Total | 113 | 40.8 | 100.0 | |
| Missing | -99.00 | 164 | 59.2 | | |
| Total | | 277 | 100.0 | | |

### 4.3.2 Waste Processing Infrastructure

**PROCESSING INFRASTRUCTURE-WASTE**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | SATISFIED | 1 | .4 | 1.0 | 1.0 |
| | NEUTRAL | 5 | 1.8 | 5.1 | 6.1 |
| | DISSATISFIED | 93 | 33.6 | 93.9 | 100.0 |
| | Total | 99 | 35.7 | 100.0 | |
| Missing | -99.00 | 178 | 64.3 | | |
| Total | | 277 | 100.0 | | |

## 4.4 Irrigation and Public access to Water

### 4.4.1 Source of Water

#### 4.4.1.1 Wells

**IRRIGATION/ACCESS TO WATER-WELL**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | SATISFIED | 123 | 44.4 | 46.2 | 46.2 |
| | NEUTRAL | 79 | 28.5 | 29.7 | 75.9 |
| | DISSATISFIED | 64 | 23.1 | 24.1 | 100.0 |
| | Total | 266 | 96.0 | 100.0 | |
| Missing | -99.00 | 11 | 4.0 | | |
| Total | | 277 | 100.0 | | |

#### 4.4.1.2 Rainfall

**IRRIGATION/ACCESS TO WATER-RAINFALL**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | SATISFIED | 54 | 19.5 | 41.2 | 41.2 |
| | NEUTRAL | 62 | 22.4 | 47.3 | 88.5 |
| | DISSATISFIED | 15 | 5.4 | 11.5 | 100.0 |
| | Total | 131 | 47.3 | 100.0 | |
| Missing | -99.00 | 146 | 52.7 | | |
| Total | | 277 | 100.0 | | |

#### 4.4.1.3 Re-used water

**IRRIGATION/ACCESS TO WATER-RE-USED WATER**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | NEUTRAL | 10 | 3.6 | 15.4 | 15.4 |
| | DISSATISFIED | 55 | 19.9 | 84.6 | 100.0 |
| | Total | 65 | 23.5 | 100.0 | |
| Missing | -99.00 | 210 | 75.8 | | |
| | System | 2 | .7 | | |
| | Total | 212 | 76.5 | | |
| Total | | 277 | 100.0 | | |

### 4.4..2 Irrigation System

#### 4.4.2.1 Drip Irrigation System

**IRRIGATION SYSTEM-DROP**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | SATISFIED | 91 | 32.9 | 65.5 | 65.5 |
| | NEUTRAL | 33 | 11.9 | 23.7 | 89.2 |
| | DISSATISFIED | 15 | 5.4 | 10.8 | 100.0 |
| | Total | 139 | 50.2 | 100.0 | |
| Missing | -99.00 | 138 | 49.8 | | |
| Total | | 277 | 100.0 | | |

#### 4.4.2.2 Sprinkler Irrigation System

**IRREGATION SYSTEM-SPRINKLER**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | SATISFIED | 109 | 39.4 | 61.6 | 61.6 |
| | NEUTRAL | 53 | 19.1 | 29.9 | 91.5 |
| | DISSATISFIED | 15 | 5.4 | 8.5 | 100.0 |
| | Total | 177 | 63.9 | 100.0 | |
| Missing | -99.00 | 100 | 36.1 | | |
| Total | | 277 | 100.0 | | |

#### 4.4.2.3 Conventional Irrigation System

**IRREGATION SYSTEM-CONVENTIONAL**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | SATISFIED | 56 | 20.2 | 44.1 | 44.1 |
| | NEUTRAL | 34 | 12.3 | 26.8 | 70.9 |
| | DISSATISFIED | 37 | 13.4 | 29.1 | 100.0 |
| | Total | 127 | 45.8 | 100.0 | |
| Missing | -99.00 | 150 | 54.2 | | |
| Total | | 277 | 100.0 | | |

## 4.5 Agricultural Research and Extension Services

**Statistics**

| | | RESEARCH AND EXTENSION-RESEARCH CENTRE | RESEARCH AND EXTENSION-TRAINING CENTRE | RESEARCH AND EXTENSION-EXTENSION SERVICES | CREDIT AND FINANCIAL INSTITUTION-AGRICULTURAL BANK | CREDIT AND FINANCIAL INSTITUTION-COMMERCIAL BANK | CREDIT AND FINANCIAL INSTITUTION-ANOTHER BANK |
|---|---|---|---|---|---|---|---|
| N | Valid | 170 | 125 | 188 | 234 | 115 | 94 |
| | Missing | 107 | 152 | 89 | 43 | 162 | 183 |

### 4.5.1 Research Centre

**RESEARCH AND EXTENSION-RESEARCH CENTRE**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | SATISFIED | 13 | 4.7 | 7.6 | 7.6 |
| | NEUTRAL | 20 | 7.2 | 11.8 | 19.4 |
| | DISSATISFIED | 137 | 49.5 | 80.6 | 100.0 |
| | Total | 170 | 61.4 | 100.0 | |
| Missing | -99.00 | 106 | 38.3 | | |
| | System | 1 | .4 | | |
| | Total | 107 | 38.6 | | |
| Total | | 277 | 100.0 | | |

### 4.5.2 Training Centre

**RESEARCH AND EXTENSION-TRAINING CENTRE**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | SATISFIED | 9 | 3.2 | 7.2 | 7.2 |
| | NEUTRAL | 13 | 4.7 | 10.4 | 17.6 |
| | DISSATISFIED | 103 | 37.2 | 82.4 | 100.0 |
| | Total | 125 | 45.1 | 100.0 | |
| Missing | -99.00 | 152 | 54.9 | | |
| Total | | 277 | 100.0 | | |

## 4.5.3 Extension Services

**RESEARCH AND EXTENSION-EXTENSION SERVICES**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | SATISFIED | 12 | 4.3 | 6.4 | 6.4 |
| | NEUTRAL | 35 | 12.6 | 18.6 | 25.0 |
| | DISSATISFIED | 141 | 50.9 | 75.0 | 100.0 |
| | Total | 188 | 67.9 | 100.0 | |
| Missing | -99.00 | 89 | 32.1 | | |
| Total | | 277 | 100.0 | | |

## 4.6 Credit and Financial Institutions

### 4.6.1 Agricultural Bank

**CREDIT AND FINANCIAL INSTITUTION-AGRICULTURAL BANK**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | SATISFIED | 37 | 13.4 | 15.8 | 15.8 |
| | NEUTRAL | 64 | 23.1 | 27.4 | 43.2 |
| | DISSATISFIED | 133 | 48.0 | 56.8 | 100.0 |
| | Total | 234 | 84.5 | 100.0 | |
| Missing | -99.00 | 43 | 15.5 | | |
| Total | | 277 | 100.0 | | |

### 4.6.2 Commercial Bank

**CREDIT AND FINANCIAL INSTITUTION-COMMERCIAL BANK**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | SATISFIED | 20 | 7.2 | 17.4 | 17.4 |
| | NEUTRAL | 35 | 12.6 | 30.4 | 47.8 |
| | DISSATISFIED | 60 | 21.7 | 52.2 | 100.0 |
| | Total | 115 | 41.5 | 100.0 | |
| Missing | -99.00 | 162 | 58.5 | | |
| Total | | 277 | 100.0 | | |

## 5. STATSTICAL DISTRUBATION OF FARMER'S CHOICE OF PRODUCE INFLUENCE BY THE AVALABLE AGRICULTURAL INFRASTRUCTURE

### 5.1 Transportation

**IN YOUR CHOICE OF PRODUCE INFLUENCED BY THE AVALIABLE INFRASTRUCTURE - TRANSPORTION**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY STRONGLY | 96 | 34.7 | 36.0 | 36.0 |
| | STRONGLY | 74 | 26.7 | 27.7 | 63.7 |
| | NATURAL | 54 | 19.5 | 20.2 | 83.9 |
| | WEAK | 24 | 8.7 | 9.0 | 92.9 |
| | NOT AT ALL | 19 | 6.9 | 7.1 | 100.0 |
| | Total | 267 | 96.4 | 100.0 | |
| Missing | -99.00 | 10 | 3.6 | | |
| Total | | 277 | 100.0 | | |

**5.2 Communication and Information Services**

**COMMUNICATION&INFORMATION SERVICES**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY STRONGLY | 60 | 21.7 | 23.3 | 23.3 |
| | STRONGLY | 64 | 23.1 | 24.8 | 48.1 |
| | NATURAL | 67 | 24.2 | 26.0 | 74.0 |
| | WEAK | 36 | 13.0 | 14.0 | 88.0 |
| | NOT AT ALL | 31 | 11.2 | 12.0 | 100.0 |
| | Total | 258 | 93.1 | 100.0 | |
| Missing | -99.000 | 19 | 6.9 | | |
| Total | | 277 | 100.0 | | |

## 5.3 Processing Infrastructure

**PROCESSING INFRASTRUCTURE**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY STRONGLY | 56 | 20.2 | 23.9 | 23.9 |
| | STRONGLY | 29 | 10.5 | 12.4 | 36.3 |
| | NATURAL | 29 | 10.5 | 12.4 | 48.7 |
| | WEAK | 51 | 18.4 | 21.8 | 70.5 |
| | NOT AT ALL | 69 | 24.9 | 29.5 | 100.0 |
| | Total | 234 | 84.5 | 100.0 | |
| Missing | -99.00 | 42 | 15.2 | | |
| | System | 1 | .4 | | |
| | Total | 43 | 15.5 | | |
| Total | | 277 | 100.0 | | |

## 5.4 Irrigation and Public access to water

**IRRIGATION AND PUBLIC ACCESS TO WATER**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY STRONGLY | 136 | 49.1 | 50.9 | 50.9 |
| | STRONGLY | 58 | 20.9 | 21.7 | 72.7 |
| | NATURAL | 46 | 16.6 | 17.2 | 89.9 |
| | WEAK | 15 | 5.4 | 5.6 | 95.5 |
| | NOT AT ALL | 12 | 4.3 | 4.5 | 100.0 |
| | Total | 267 | 96.4 | 100.0 | |
| Missing | -99.00 | 10 | 3.6 | | |
| Total | | 277 | 100.0 | | |

## 5.5 Agricultural Research and Extension Services

**AGRICULTURAL RESEARCH AND EXTENSION SERVICES**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY STRONGLY | 55 | 19.9 | 21.7 | 21.7 |
| | STRONGLY | 33 | 11.9 | 13.0 | 34.8 |
| | NATURAL | 44 | 15.9 | 17.4 | 52.2 |
| | WEAK | 69 | 24.9 | 27.3 | 79.4 |
| | NOT AT ALL | 52 | 18.8 | 20.6 | 100.0 |
| | Total | 253 | 91.3 | 100.0 | |
| Missing | -99.00 | 24 | 8.7 | | |
| Total | | 277 | 100.0 | | |

## 5.6 Credit and financial Institutions

**CREDIT AND FINANCIAL INSTITIONS**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY STRONGLY | 76 | 27.4 | 29.2 | 29.2 |
| | STRONGLY | 50 | 18.1 | 19.2 | 48.5 |
| | NATURAL | 42 | 15.2 | 16.2 | 64.6 |
| | WEAK | 44 | 15.9 | 16.9 | 81.5 |
| | NOT AT ALL | 48 | 17.3 | 18.5 | 100.0 |
| | Total | 260 | 93.9 | 100.0 | |
| Missing | -99.00 | 17 | 6.1 | | |
| Total | | 277 | 100.0 | | |

## 5.7 Markets

**IN YOUR CHOICE OF PRODUCE INFLUENCED BY THE AVALIABLE INFRASTRUCTURE-MARKETS**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY STRONGLY | 127 | 45.8 | 47.7 | 47.7 |
| | STRONGLY | 56 | 20.2 | 21.1 | 68.8 |
| | NATURAL | 40 | 14.4 | 15.0 | 83.8 |
| | WEAK | 31 | 11.2 | 11.7 | 95.5 |
| | NOT AT ALL | 12 | 4.3 | 4.5 | 100.0 |
| | Total | 266 | 96.0 | 100.0 | |
| Missing | -99.00 | 11 | 4.0 | | |
| Total | | 277 | 100.0 | | |

## 6. STATSTICAL DISTRUBATION OF HOW IMPORTANT WERE THE CURRENT INFRASTRUCTURE IN THE USE OF INPUTS.

### 6.1. Transportation with Agricultural Inputs

#### 6.1 .1 Transportation With Chemical Fertilizer

**HOW IMPORTANT WERE THE CURRENT INFRASTRUCTURE IN THE USE OF INPUTS-TRANSPORTION/CHEMICAL FERTILIZER**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY IMPORTANT | 166 | 59.9 | 64.3 | 64.3 |
| | IMPORTANT | 79 | 28.5 | 30.6 | 95.0 |
| | NOT IMPORTANT | 13 | 4.7 | 5.0 | 100.0 |
| | Total | 258 | 93.1 | 100.0 | |
| Missing | -99.00 | 19 | 6.9 | | |
| Total | | 277 | 100.0 | | |

#### 6.1.2 Transportation With Manure Fertilizer

**TRANSPORTION/MANURE FERTILIZER**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY IMPORTANT | 107 | 38.6 | 41.3 | 41.3 |
| | IMPORTANT | 120 | 43.3 | 46.3 | 87.6 |
| | NOT IMPORTANT | 32 | 11.6 | 12.4 | 100.0 |
| | Total | 259 | 93.5 | 100.0 | |
| Missing | -99.00 | 18 | 6.5 | | |
| Total | | 277 | 100.0 | | |

#### 6..1. 3 Transportation With Seeds

**TRANSPORTION/SEEDS**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY IMPORTANT | 116 | 41.9 | 45.3 | 45.3 |
| | IMPORTANT | 119 | 43.0 | 46.5 | 91.8 |
| | NOT IMPORTANT | 21 | 7.6 | 8.2 | 100.0 |
| | Total | 256 | 92.4 | 100.0 | |
| Missing | -99.00 | 21 | 7.6 | | |
| Total | | 277 | 100.0 | | |

6..1.4 Transportation With Pesticides

**TRANSPORTION/PESTICIDES**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY IMPORTANT | 141 | 50.9 | 56.4 | 56.4 |
| | IMPORTANT | 96 | 34.7 | 38.4 | 94.8 |
| | NOT IMPORTANT | 13 | 4.7 | 5.2 | 100.0 |
| | Total | 250 | 90.3 | 100.0 | |
| Missing | -99.00 | 27 | 9.7 | | |
| Total | | 277 | 100.0 | | |

6.1.5 Transportation With Machinery Equipment

**TRANSPORTION/MACHINERY&EQUIPMENT**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY IMPORTANT | 173 | 62.5 | 67.3 | 67.3 |
| | IMPORTANT | 76 | 27.4 | 29.6 | 96.9 |
| | NOT IMPORTANT | 8 | 2.9 | 3.1 | 100.0 |
| | Total | 257 | 92.8 | 100.0 | |
| Missing | -99.00 | 20 | 7.2 | | |
| Total | | 277 | 100.0 | | |

6.2 Communication and Information services With Agricultural Inputs
6.2.1 Communication and Information services With chemical Fertilizer

**COMMUNICATION&INFORMATION SERVICES/CHEMICAL FERTILIZER**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY IMPORTANT | 82 | 29.6 | 32.4 | 32.4 |
| | IMPORTANT | 114 | 41.2 | 45.1 | 77.5 |
| | NOT IMPORTANT | 57 | 20.6 | 22.5 | 100.0 |
| | Total | 253 | 91.3 | 100.0 | |
| Missing | -99.00 | 24 | 8.7 | | |
| Total | | 277 | 100.0 | | |

### 6.2.2 Communication and Information services With Manure Fertilizer

**COMMUNICATION&INFORMATION SERVICES/MANURE FERTILIZER**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY IMPORTANT | 39 | 14.1 | 16.0 | 16.0 |
| | IMPORTANT | 97 | 35.0 | 39.9 | 56.0 |
| | NOT IMPORTANT | 107 | 38.6 | 44.0 | 100.0 |
| | Total | 243 | 87.7 | 100.0 | |
| Missing | -99.00 | 34 | 12.3 | | |
| Total | | 277 | 100.0 | | |

### 6.2.3 Communication and Information services With seeds

**COMMUNICATION&INFORMATION SERVICES/SEEDS**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY IMPORTANT | 60 | 21.7 | 24.7 | 24.7 |
| | IMPORTANT | 123 | 44.4 | 50.6 | 75.3 |
| | NOT IMPORTANT | 60 | 21.7 | 24.7 | 100.0 |
| | Total | 243 | 87.7 | 100.0 | |
| Missing | -99.00 | 34 | 12.3 | | |
| Total | | 277 | 100.0 | | |

### 6.2.4 Communication and Information services With Pesticides

**COMMUNICATION&INFORMATION SERVICES/PESTICIDES**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY IMPORTANT | 81 | 29.2 | 33.8 | 33.8 |
| | IMPORTANT | 109 | 39.4 | 45.4 | 79.2 |
| | NOT IMPORTANT | 50 | 18.1 | 20.8 | 100.0 |
| | Total | 240 | 86.6 | 100.0 | |
| Missing | -99.00 | 37 | 13.4 | | |
| Total | | 277 | 100.0 | | |

6.2.5 Communication and Information services With Machinery equipment

**COMMUNICATION&INFORMATION SERVICES/MACHINERY&EQUPMENT**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY IMPORTANT | 109 | 39.4 | 44.5 | 44.5 |
| | IMPORTANT | 97 | 35.0 | 39.6 | 84.1 |
| | NOT IMPORTANT | 39 | 14.1 | 15.9 | 100.0 |
| | Total | 245 | 88.4 | 100.0 | |
| Missing | -99.00 | 32 | 11.6 | | |
| Total | | 277 | 100.0 | | |

6.3 Processing Infrastructure with Agricultural Inputs

6.3.1 Processing Infrastructure With Chemical Fertilizer

**PROCESSING INFRASTRUCTURE/CHEMICAL FERTILIZER**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY IMPORTANT | 63 | 22.7 | 27.9 | 27.9 |
| | IMPORTANT | 64 | 23.1 | 28.3 | 56.2 |
| | NOT IMPORTANT | 99 | 35.7 | 43.8 | 100.0 |
| | Total | 226 | 81.6 | 100.0 | |
| Missing | -99.00 | 51 | 18.4 | | |
| Total | | 277 | 100.0 | | |

6.3.2 Processing Infrastructure With Manure Fertilizer

**PROCESSING INFRASTRUCTURE/MANURE FERTILIZER**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY IMPORTANT | 38 | 13.7 | 17.8 | 17.8 |
| | IMPORTANT | 62 | 22.4 | 29.1 | 46.9 |
| | NOT IMPORTANT | 113 | 40.8 | 53.1 | 100.0 |
| | Total | 213 | 76.9 | 100.0 | |
| Missing | -99.00 | 64 | 23.1 | | |
| Total | | 277 | 100.0 | | |

### 6.3.3 Processing Infrastructure With Seeds

**PROCESSING INFRASTRUCTURE/SEEDS**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY IMPORTANT | 47 | 17.0 | 22.2 | 22.2 |
| | IMPORTANT | 69 | 24.9 | 32.5 | 54.7 |
| | NOT IMPORTANT | 96 | 34.7 | 45.3 | 100.0 |
| | Total | 212 | 76.5 | 100.0 | |
| Missing | -99.00 | 65 | 23.5 | | |
| Total | | 277 | 100.0 | | |

### 6.3.4 Processing Infrastructure with Pesticides

**PROCESSING INFRASTRUCTURE/PESTICIDES**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY IMPORTANT | 52 | 18.8 | 24.6 | 24.6 |
| | IMPORTANT | 65 | 23.5 | 30.8 | 55.5 |
| | NOT IMPORTANT | 94 | 33.9 | 44.5 | 100.0 |
| | Total | 211 | 76.2 | 100.0 | |
| Missing | -99.00 | 66 | 23.8 | | |
| Total | | 277 | 100.0 | | |

### 6.3.5 Processing Infrastructure with Machinary Equipment

**PROCESSING INFRASTRUCTURE/MACHINERY&EQUPMENT**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY IMPORTANT | 60 | 21.7 | 28.2 | 28.2 |
| | IMPORTANT | 57 | 20.6 | 26.8 | 54.9 |
| | NOT IMPORTANT | 96 | 34.7 | 45.1 | 100.0 |
| | Total | 213 | 76.9 | 100.0 | |
| Missing | -99.00 | 64 | 23.1 | | |
| Total | | 277 | 100.0 | | |

### 6.4 Irrigation and Public access to water with Agricultural Inputs

#### 6.4.1 Irrigation and public access to Water with Chemical Fertilizer

**IRRIGATION AND PUBLIC ACCESS TO WATER/CHEMICAL FERTILIZER**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY IMPORTANT | 153 | 55.2 | 63.2 | 63.2 |
| | IMPORTANT | 57 | 20.6 | 23.6 | 86.8 |
| | NOT IMPORTANT | 32 | 11.6 | 13.2 | 100.0 |
| | Total | 242 | 87.4 | 100.0 | |
| Missing | -99.00 | 35 | 12.6 | | |
| Total | | 277 | 100.0 | | |

#### 6.4.2 Irrigation and public access to Water with Manure Fertilizer

**IRRIGATION AND PUBLIC ACCESS TO WATER/MANURE FARTILIZER**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY IMPORTANT | 134 | 48.4 | 58.0 | 58.0 |
| | IMPORTANT | 63 | 22.7 | 27.3 | 85.3 |
| | NOT IMPORTANT | 34 | 12.3 | 14.7 | 100.0 |
| | Total | 231 | 83.4 | 100.0 | |
| Missing | -99.00 | 46 | 16.6 | | |
| Total | | 277 | 100.0 | | |

#### 6.4.3 Irrigation and public access to Water with Sseds

**IRRIGATION AND PUBLIC ACCESS TO WATER/SEEDS**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY IMPORTANT | 134 | 48.4 | 58.3 | 58.3 |
| | IMPORTANT | 62 | 22.4 | 27.0 | 85.2 |
| | NOT IMPORTANT | 34 | 12.3 | 14.8 | 100.0 |
| | Total | 230 | 83.0 | 100.0 | |
| Missing | -99.00 | 47 | 17.0 | | |
| Total | | 277 | 100.0 | | |

6.4.4 Irrigation and public access to Water with Pestisides

**IRRIGATION AND PUBLIC ACCESS TO WATER/PESTICIDES**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY IMPORTANT | 125 | 45.1 | 55.1 | 55.1 |
| | IMPORTANT | 58 | 20.9 | 25.6 | 80.6 |
| | NOT IMPORTANT | 44 | 15.9 | 19.4 | 100.0 |
| | Total | 227 | 81.9 | 100.0 | |
| Missing | -99.00 | 50 | 18.1 | | |
| Total | | 277 | 100.0 | | |

6.4.5 Irrigation and public access to Water with Machinery Equipment

**IRRIGATION AND PUBLIC ACCESS TO WATER/MACHINERY&EQUPMENT**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY IMPORTANT | 122 | 44.0 | 53.3 | 53.3 |
| | IMPORTANT | 74 | 26.7 | 32.3 | 85.6 |
| | NOT IMPORTANT | 33 | 11.9 | 14.4 | 100.0 |
| | Total | 229 | 82.7 | 100.0 | |
| Missing | -99.00 | 48 | 17.3 | | |
| Total | | 277 | 100.0 | | |

6.5 Agricultural Research and Extension Services and agricultural Inputs

6.5.1 Agricultural Research and Extension Services with Chemical Fertilizer

**AGRICULTURAL RESEARCH AND EXTENSION SERVICES/CHEMICAL FERTILIZER**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY IMPORTANT | 89 | 32.1 | 37.6 | 37.6 |
| | IMPORTANT | 89 | 32.1 | 37.6 | 75.1 |
| | NOT IMPORTANT | 59 | 21.3 | 24.9 | 100.0 |
| | Total | 237 | 85.6 | 100.0 | |
| Missing | -99.00 | 40 | 14.4 | | |
| Total | | 277 | 100.0 | | |

### 6.5. 2 Agricultural Research and Extension Services with Manure Fertilizer

**AGRICULTURAL RESEARCH AND EXTENSION SERVICES/MANURE FARTILIZER**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY IMPORTANT | 59 | 21.3 | 26.6 | 26.6 |
| | IMPORTANT | 77 | 27.8 | 34.7 | 61.3 |
| | NOT IMPORTANT | 86 | 31.0 | 38.7 | 100.0 |
| | Total | 222 | 80.1 | 100.0 | |
| Missing | -99.00 | 55 | 19.9 | | |
| Total | | 277 | 100.0 | | |

### 6.5. 3 Agricultural Research and Extension Services with Seeds

**AGRICULTURAL RESEARCH AND EXTENSION SERVICES/SEEDS**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY IMPORTANT | 70 | 25.3 | 31.8 | 31.8 |
| | IMPORTANT | 92 | 33.2 | 41.8 | 73.6 |
| | NOT IMPORTANT | 58 | 20.9 | 26.4 | 100.0 |
| | Total | 220 | 79.4 | 100.0 | |
| Missing | -99.00 | 57 | 20.6 | | |
| Total | | 277 | 100.0 | | |

### 6.5. 3 Agricultural Research and Extension Services with Pesticides

**AGRICULTURAL RESEARCH AND EXTENSION SERVICES/PESTICIDES**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY IMPORTANT | 84 | 30.3 | 37.3 | 37.3 |
| | IMPORTANT | 82 | 29.6 | 36.4 | 73.8 |
| | NOT IMPORTANT | 59 | 21.3 | 26.2 | 100.0 |
| | Total | 225 | 81.2 | 100.0 | |
| Missing | -99.00 | 52 | 18.8 | | |
| Total | | 277 | 100.0 | | |

### 6.5. 4 Agricultural Research and Extension Services with Machinery Equipment

**AGRICULTURAL RESEARCH AND EXTENSION SERVICES/MACHINERY&EQUIPMENT**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY IMPORTANT | 71 | 25.6 | 31.7 | 31.7 |
| | IMPORTANT | 79 | 28.5 | 35.3 | 67.0 |
| | NOT IMPORTANT | 74 | 26.7 | 33.0 | 100.0 |
| | Total | 224 | 80.9 | 100.0 | |
| Missing | -99.00 | 53 | 19.1 | | |
| Total | | 277 | 100.0 | | |

## 6.6 Credit and Financial Institutions with Agricultural Inputs

### 6.6.1 Credit and Financial Institutions with Chemical Fertilizer

**CREDIT AND FINANCIAL INSTITIONS/CHEMICAL FERTILIZER**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY IMPORTANT | 93 | 33.6 | 38.3 | 38.3 |
| | IMPORTANT | 98 | 35.4 | 40.3 | 78.6 |
| | NOT IMPORTANT | 52 | 18.8 | 21.4 | 100.0 |
| | Total | 243 | 87.7 | 100.0 | |
| Missing | -99.00 | 34 | 12.3 | | |
| Total | | 277 | 100.0 | | |

### 6.6.2 Credit and Financial Institutions with Manure Fertilizer

**CREDIT AND FINANCIAL INSTITIONS/MANURE FARTILIZER**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY IMPORTANT | 57 | 20.6 | 25.3 | 25.3 |
| | IMPORTANT | 72 | 26.0 | 32.0 | 57.3 |
| | NOT IMPORTANT | 96 | 34.7 | 42.7 | 100.0 |
| | Total | 225 | 81.2 | 100.0 | |
| Missing | -99.00 | 52 | 18.8 | | |
| Total | | 277 | 100.0 | | |

### 6.6.3 Credit and Financial Institutions with Seeds

**CREDIT AND FINANCIAL INSTITIONS/SEEDS**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY IMPORTANT | 66 | 23.8 | 29.6 | 29.6 |
| | IMPORTANT | 98 | 35.4 | 43.9 | 73.5 |
| | NOT IMPORTANT | 59 | 21.3 | 26.5 | 100.0 |
| | Total | 223 | 80.5 | 100.0 | |
| Missing | -99.00 | 54 | 19.5 | | |
| Total | | 277 | 100.0 | | |

### 6,6.4 Credit and Financial Institutions with Pesticides

**CREDIT AND FINANCIAL INSTITIONS/PESICIDES**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY IMPORTANT | 80 | 28.9 | 35.9 | 35.9 |
| | IMPORTANT | 87 | 31.4 | 39.0 | 74.9 |
| | NOT IMPORTANT | 56 | 20.2 | 25.1 | 100.0 |
| | Total | 223 | 80.5 | 100.0 | |
| Missing | -99.00 | 54 | 19.5 | | |
| Total | | 277 | 100.0 | | |

### 6.6.5 Credit and Financial Institutions with Machinery Equipment

**CREDIT AND FINANCIAL INSTITIONS/MACHINERY& EQUIPMENT**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY IMPORTANT | 129 | 46.6 | 56.3 | 56.3 |
| | IMPORTANT | 59 | 21.3 | 25.8 | 82.1 |
| | NOT IMPORTANT | 41 | 14.8 | 17.9 | 100.0 |
| | Total | 229 | 82.7 | 100.0 | |
| Missing | -99.00 | 48 | 17.3 | | |
| Total | | 277 | 100.0 | | |

### 6.7 Markets with Agricultural Inputs

### 6.7.1 Markets with chemical Fertilizer

**HOW IMPORTANT WERE THE CURRENT INFRASTRUCTURE IN THE USE OF INPUTS-MARKETS/CHEMICAL FERTILIZER**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY IMPORTANT | 154 | 55.6 | 62.6 | 62.6 |
| | IMPORTANT | 79 | 28.5 | 32.1 | 94.7 |
| | NOT IMPORTANT | 13 | 4.7 | 5.3 | 100.0 |
| | Total | 246 | 88.8 | 100.0 | |
| Missing | -99.00 | 31 | 11.2 | | |
| Total | | 277 | 100.0 | | |

### 6.7.2 Markets with Manure Fertilizer

HOW INPORTANT WERE THE CURRENT INFRASTRUCTURE IN THE USE OF INPUTS-MARKETS/MANURA FARTILIZER

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY IMPORTANT | 106 | 38.3 | 45.9 | 45.9 |
| | IMPORTANT | 82 | 29.6 | 35.5 | 81.4 |
| | NOT IMPORTANT | 42 | 15.2 | 18.2 | 99.6 |
| | 99.00 | 1 | .4 | .4 | 100.0 |
| | Total | 231 | 83.4 | 100.0 | |
| Missing | -99.00 | 46 | 16.6 | | |
| Total | | 277 | 100.0 | | |

### 6.7.3 Markets with Seeds

**HOW IMPORTANT WERE THE CURRENT INFRASTRUCTURE IN THE USE OF INPUTS-MARKETS/SEEDS**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY IMPORTANT | 121 | 43.7 | 51.9 | 51.9 |
| | IMPORTANT | 101 | 36.5 | 43.3 | 95.3 |
| | NOT IMPORTANT | 11 | 4.0 | 4.7 | 100.0 |
| | Total | 233 | 84.1 | 100.0 | |
| Missing | -99.00 | 44 | 15.9 | | |
| Total | | 277 | 100.0 | | |

### 6.7.4 Markets with Pesticides

**HOW IMPORTANT WERE THE CURRENT INFRASTRUCTUE INTHE USE OF INPUTS-MARKETS/PESTICIDES**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY IMPORTANT | 132 | 47.7 | 56.4 | 56.4 |
| | IMPORTANT | 91 | 32.9 | 38.9 | 95.3 |
| | NOT IMPORTANT | 11 | 4.0 | 4.7 | 100.0 |
| | Total | 234 | 84.5 | 100.0 | |
| Missing | -99.00 | 43 | 15.5 | | |
| Total | | 277 | 100.0 | | |

### 6.7.5 Markets with Machinery Equipment

**HOW IMPORTANT WERE THE CURRENT INFRASTRUCTURE IN THE USE OF INPUTS-MARKETS/&MACHINERY& EQUIPMENT**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | VERY IMPORTANT | 140 | 50.5 | 60.1 | 60.1 |
| | IMPORTANT | 80 | 28.9 | 34.3 | 94.4 |
| | NOT IMPORTANT | 13 | 4.7 | 5.6 | 100.0 |
| | Total | 233 | 84.1 | 100.0 | |
| Missing | -99.00 | 44 | 15.9 | | |
| Total | | 277 | 100.0 | | |

## 7. STATSTICAL DISTRUBATION OF THE CURRENT AVAILABLE INFRASTRUCTURE AND FARMERS DECISION

### 7.1 Current Available Infrastructure with Agri-land Holding

**HOW IMPORTANT WERE CURRENT INFRASTRUCTURE IN YOUR DECISION/ EXTEND YOUR AREA OF AGRI-LAND HOLDING**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | EXTERMELY IMPORTANT | 137 | 49.5 | 50.6 | 50.6 |
| | VERY IMPORTANT | 79 | 28.5 | 29.2 | 79.7 |
| | IMPORTANT | 42 | 15.2 | 15.5 | 95.2 |
| | NOT AT ALL | 13 | 4.7 | 4.8 | 100.0 |
| | Total | 271 | 97.8 | 100.0 | |
| Missing | -99.00 | 6 | 2.2 | | |
| Total | | 277 | 100.0 | | |

### 7.2 Current Available Infrastructure with produce a greater variety of crops

**HOW IMPORTANT WERE CURRENT INFRASTRUCTURE/TO PRODUCE A GREATER VARIETY OF CROPS**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | EXTERMELY IMPORTANT | 98 | 35.4 | 36.6 | 36.6 |
| | VERY IMPORTANT | 107 | 38.6 | 39.9 | 76.5 |
| | IMPORTANT | 43 | 15.5 | 16.0 | 92.5 |
| | NOT AT ALL | 20 | 7.2 | 7.5 | 100.0 |
| | Total | 268 | 96.8 | 100.0 | |
| Missing | -99.00 | 9 | 3.2 | | |
| Total | | 277 | 100.0 | | |

## 7.3 Current Available Infrastructure with Agricultural Practices

**HOW IMPORTANT WERE CURRENT INFRASTRUCTURE IN YOUR DECISION/ UNDER TAKE ALL NECESSARY AGRICULTURAL PRACTICES**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | EXTERMELY IMPORTANT | 102 | 36.8 | 38.5 | 38.5 |
| | VERY IMPORTANT | 82 | 29.6 | 30.9 | 69.4 |
| | IMPORTANT | 62 | 22.4 | 23.4 | 92.8 |
| | NOT AT ALL | 19 | 6.9 | 7.2 | 100.0 |
| | Total | 265 | 95.7 | 100.0 | |
| Missing | -99.00 | 12 | 4.3 | | |
| Total | | 277 | 100.0 | | |

## 7.4 Current Available Infrastructure with Introduce New Technology

**HOW IMPORTANT WERE CURRENT INFRASTRUCTURE IN YOUR DECISION/ TO INTRODUCE NEW TECHNOLOGY**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | EXTERMELY IMPORTANT | 120 | 43.3 | 45.3 | 45.3 |
| | VERY IMPORTANT | 75 | 27.1 | 28.3 | 73.6 |
| | IMPORTANT | 48 | 17.3 | 18.1 | 91.7 |
| | NOT AT ALL | 22 | 7.9 | 8.3 | 100.0 |
| | Total | 265 | 95.7 | 100.0 | |
| Missing | -99.00 | 11 | 4.0 | | |
| | System | 1 | .4 | | |
| | Total | 12 | 4.3 | | |
| Total | | 277 | 100.0 | | |

## 7.5 Current Available Infrastructure with Introduce New Agricultural Methods

**HOW IMPORTANT WERE CURRENT INFRASTRUCTURE IN YOUR DECISION/ TO INTRODUCE NEW AGRICULTURAL METHODS**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | EXTERMELY IMPORTANT | 113 | 40.8 | 42.8 | 42.8 |
| | VERY IMPORTANT | 64 | 23.1 | 24.2 | 67.0 |
| | IMPORTANT | 55 | 19.9 | 20.8 | 87.9 |
| | NOT AT ALL | 32 | 11.6 | 12.1 | 100.0 |
| | Total | 264 | 95.3 | 100.0 | |
| Missing | -99.00 | 13 | 4.7 | | |
| Total | | 277 | 100.0 | | |

## 7.6 Current Available Infrastructure with Generate Higher Profit Introduce New Agricultural Methods

**HOW IMPORTANT WERE CURRENT INFRASTRUCTURE IN YOUR DECISION/ TO GENERATE HIGHER PROFIT**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | EXTERMELY IMPORTANT | 174 | 62.8 | 66.2 | 66.2 |
| | VERY IMPORTANT | 52 | 18.8 | 19.8 | 85.9 |
| | IMPORTANT | 23 | 8.3 | 8.7 | 94.7 |
| | NOT AT ALL | 14 | 5.1 | 5.3 | 100.0 |
| | Total | 263 | 94.9 | 100.0 | |
| Missing | -99.00 | 14 | 5.1 | | |
| Total | | 277 | 100.0 | | |

## 8.STATSTICAL DISTRUBTION ABOUT IN YOUR OPINION,DO YOU THINK AVAILABLE INFRASTRUCTURE ENABLES YOU TO ADDRESS ORGANIC FARMING PRACTICES AND PRINCIPLES

### 8.1 Current available Infrastructure and Soil Fertility

**IN YOUR OPINION,DO YOU THINK AVAILABLE INFRASTRUCTURE ENABLES YOU TO ADDRESS/ CARING AND LONG TERM SOIL FERTILITY**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | YES | 156 | 56.3 | 58.4 | 58.4 |
| | NO | 45 | 16.2 | 16.9 | 75.3 |
| | DON'T KNOW | 66 | 23.8 | 24.7 | 100.0 |
| | Total | 267 | 96.4 | 100.0 | |
| Missing | -99.00 | 10 | 3.6 | | |
| Total | | 277 | 100.0 | | |

### 8.2 Current available Infrastructure and Soil Rotation

**IN YOUR OPINION,DO YOU THINK AVAILABLE INFRASTRUCTURE ENABLES YOU TO ADDRESS /FOLLOWING SOIL ROTATION**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | YES | 151 | 54.5 | 58.1 | 58.1 |
| | NO | 44 | 15.9 | 16.9 | 75.0 |
| | DON'T KNOW | 65 | 23.5 | 25.0 | 100.0 |
| | Total | 260 | 93.9 | 100.0 | |
| Missing | -99.00 | 17 | 6.1 | | |
| Total | | 277 | 100.0 | | |

### 8.3 Current available Infrastructure and Usage of Chemical fertilizer

**IN YOUR OPINION,DO YOU THINK AVAILABLE INFRASTRUCTURE ENABLES YOU TO ADDRESS/USE OF CHEMICAL FERTILIZER**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | YES | 115 | 41.5 | 43.6 | 43.6 |
| | NO | 110 | 39.7 | 41.7 | 85.2 |
| | DON'T KNOW | 39 | 14.1 | 14.8 | 100.0 |
| | Total | 264 | 95.3 | 100.0 | |
| Missing | -99.00 | 13 | 4.7 | | |

**IN YOUR OPINION,DO YOU THINK AVAILABLE INFRASTRUCTURE ENABLES YOU TO ADDRESS/USE OF CHEMICAL FERTILIZER**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | YES | 115 | 41.5 | 43.6 | 43.6 |
| | NO | 110 | 39.7 | 41.7 | 85.2 |
| | DON'T KNOW | 39 | 14.1 | 14.8 | 100.0 |
| | Total | 264 | 95.3 | 100.0 | |
| Missing | -99.00 | 13 | 4.7 | | |
| Total | | 277 | 100.0 | | |

## 8.4 Current available Infrastructure and Usage of Biological Control

**IN YOUR OPINION,DO YOU THINK AVAILABLE INFRASTRUCTURE ENABLES YOU TO ADDRESS/ USE OF BIOLOGICAL COMBAT**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | YES | 97 | 35.0 | 38.6 | 38.6 |
| | NO | 73 | 26.4 | 29.1 | 67.7 |
| | DON'T KNOW | 81 | 29.2 | 32.3 | 100.0 |
| | Total | 251 | 90.6 | 100.0 | |
| Missing | -99.00 | 26 | 9.4 | | |
| Total | | 277 | 100.0 | | |

## 8.5 Current available Infrastructure and Usage of Manure Fertilizer

**IN YOUR OPINION,DO YOU THINK AVAILABLE INFRASTRUCTURE ENABLES YOU TO ADDRESS/ USE OF MANURE FERTILIZER**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | YES | 172 | 62.1 | 65.4 | 65.4 |
| | NO | 60 | 21.7 | 22.8 | 88.2 |
| | DON'T KNOW | 31 | 11.2 | 11.8 | 100.0 |
| | Total | 263 | 94.9 | 100.0 | |
| Missing | -99.00 | 14 | 5.1 | | |
| Total | | 277 | 100.0 | | |

## Section 2. Correlation Analysis

### 2.1. Age and Education

**Case Processing Summary**

| | Cases | | | | | |
|---|---|---|---|---|---|---|
| | Valid | | Missing | | Total | |
| | N | Percent | N | Percent | N | Percent |
| AGE RECODE * LEVEL OF EDUCATION | 228 | 82.3% | 49 | 17.7% | 277 | 100.0% |

**AGE RECODE * EDUCATION RECORDED Crosstabulation**

| | | | EDUCATION RECORDED | | | Total |
|---|---|---|---|---|---|---|
| | | | Formal & other | Primary /High Sch | University | |
| AGE RECODE | 30-51 | Count | 11 | 56 | 36 | 103 |
| | | % within AGE RECODE | 10.7% | 54.4% | 35.0% | 100.0% |
| | | % within EDUCATION RECORDED | 19.3% | 47.5% | 67.9% | 45.2% |
| | | % of Total | 4.8% | 24.6% | 15.8% | 45.2% |
| | 52-73 | Count | 34 | 58 | 16 | 108 |
| | | % within AGE RECODE | 31.5% | 53.7% | 14.8% | 100.0% |
| | | % within EDUCATION RECORDED | 59.6% | 49.2% | 30.2% | 47.4% |
| | | % of Total | 14.9% | 25.4% | 7.0% | 47.4% |
| | 74+ | Count | 12 | 4 | 1 | 17 |
| | | % within AGE RECODE | 70.6% | 23.5% | 5.9% | 100.0% |
| | | % within EDUCATION RECORDED | 21.1% | 3.4% | 1.9% | 7.5% |
| | | % of Total | 5.3% | 1.8% | .4% | 7.5% |
| Total | | Count | 57 | 118 | 53 | 228 |
| | | % within AGE RECODE | 25.0% | 51.8% | 23.2% | 100.0% |
| | | % within EDUCATION RECORDED | 100.0% | 100.0% | 100.0% | 100.0% |
| | | % of Total | 25.0% | 51.8% | 23.2% | 100.0% |

**Chi-Square Tests**

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 38.807[a] | 4 | .000 |
| Likelihood Ratio | 37.579 | 4 | .000 |
| Linear-by-Linear Association | 33.179 | 1 | .000 |
| N of Valid Cases | 228 | | |

a. 2 cells (22.2%) have expected count less than 5. The minimum expected count is 3.95.

**Symmetric Measures**

| | | Value | Approx. Sig. |
|---|---|---|---|
| Nominal by Nominal | Phi | .413 | .000 |
| | Cramer's V | .292 | .000 |
| N of Valid Cases | | 228 | |

## 2..2 Age and Agricultural Regions

**Case Processing Summary**

| | Cases | | | | | |
|---|---|---|---|---|---|---|
| | Valid | | Missing | | Total | |
| | N | Percent | N | Percent | N | Percent |
| AGRICULTURAL REGIONS * AGE | 230 | 83.0% | 47 | 17.0% | 277 | 100.0% |

**AGRICULTURAL REGIONS * AGE Crosstabulation**

| | | | AGE | | | | | Total |
|---|---|---|---|---|---|---|---|---|
| | | | 30-40 | 41-51 | 52-62 | 63-73 | 74+ | |
| AGRICULTURAL REGIONS | AL-GABAL AL-AKDER | Count | 9 | 23 | 33 | 22 | 5 | 92 |
| | | % within AGRICULTURAL REGIONS | 9.8% | 25.0% | 35.9% | 23.9% | 5.4% | 100.0% |
| | | % within AGE | 23.7% | 34.8% | 55.0% | 44.9% | 29.4% | 40.0% |
| | | % of Total | 3.9% | 10.0% | 14.3% | 9.6% | 2.2% | 40.0% |
| | ALJAFARA | Count | 15 | 11 | 14 | 17 | 8 | 65 |
| | | % within AGRICULTURAL REGIONS | 23.1% | 16.9% | 21.5% | 26.2% | 12.3% | 100.0% |
| | | % within AGE | 39.5% | 16.7% | 23.3% | 34.7% | 47.1% | 28.3% |
| | | % of Total | 6.5% | 4.8% | 6.1% | 7.4% | 3.5% | 28.3% |
| | FAZZAN | Count | 14 | 32 | 13 | 10 | 4 | 73 |
| | | % within AGRICULTURAL REGIONS | 19.2% | 43.8% | 17.8% | 13.7% | 5.5% | 100.0% |
| | | % within AGE | 36.8% | 48.5% | 21.7% | 20.4% | 23.5% | 31.7% |
| | | % of Total | 6.1% | 13.9% | 5.7% | 4.3% | 1.7% | 31.7% |
| Total | | Count | 38 | 66 | 60 | 49 | 17 | 230 |
| | | % within AGRICULTURAL REGIONS | 16.5% | 28.7% | 26.1% | 21.3% | 7.4% | 100.0% |
| | | % within AGE | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% | 100.0% |
| | | % of Total | 16.5% | 28.7% | 26.1% | 21.3% | 7.4% | 100.0% |

**Chi-Square Tests**

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 25.705[a] | 8 | .001 |
| Likelihood Ratio | 25.563 | 8 | .001 |
| Linear-by-Linear Association | 6.284 | 1 | .012 |
| N of Valid Cases | 230 | | |

**Chi-Square Tests**

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 25.705[a] | 8 | .001 |
| Likelihood Ratio | 25.563 | 8 | .001 |
| Linear-by-Linear Association | 6.284 | 1 | .012 |
| N of Valid Cases | 230 | | |

a. 1 cells (6.7%) have expected count less than 5. The minimum expected count is 4.80.

**Symmetric Measures**

| | | Value | Asymp. Std. Error[a] | Approx. T[b] | Approx. Sig. |
|---|---|---|---|---|---|
| Nominal by Nominal | Phi | .334 | | | .001 |
| | Cramer's V | .236 | | | .001 |
| Interval by Interval | Pearson's R | -.166 | .061 | -2.536 | .012[c] |
| Ordinal by Ordinal | Spearman Correlation | -.177 | .061 | -2.711 | .007[c] |
| N of Valid Cases | | 230 | | | |

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

## 2..3 Level of Education and Experience

**Case Processing Summary**

| | Cases | | | | | |
|---|---|---|---|---|---|---|
| | Valid | | Missing | | Total | |
| | N | Percent | N | Percent | N | Percent |
| LEVEL OF EDUCATION * EXPERIENCE RECODE | 274 | 98.9% | 3 | 1.1% | 277 | 100.0% |
| | | | | | | |

**LEVEL OF EDUCATION * EXPERIENCE RECODE Crosstabulation**

| | | | EXPERIENCE RECODE | | | |
|---|---|---|---|---|---|---|
| | | | 10-21 | 22-33 | 34+ | Total |
| LEVEL OF EDUCATION | FORMAL TRAINING | Count | 9 | 24 | 15 | 48 |
| | | within LEVEL OF EDUCATION | 18.8% | 50.0% | 31.3% | 100.0% |
| | | % within EXPERIENCE RECODE | 7.4% | 21.1% | 38.5% | 17.5% |
| | | % of Total | 3.3% | 8.8% | 5.5% | 17.5% |
| | PRIMARY SCHOOL | Count | 13 | 16 | 8 | 37 |
| | | % within LEVEL OF EDUCATION | 35.1% | 43.2% | 21.6% | 100.0% |
| | | % within EXPERIENCE RECODE | 10.7% | 14.0% | 20.5% | 13.5% |
| | | % of Total | 4.7% | 5.8% | 2.9% | 13.5% |
| | SECONDARY SCHOOL | Count | 22 | 20 | 2 | 44 |
| | | % within LEVEL OF EDUCATION | 50.0% | 45.5% | 4.5% | 100.0% |
| | | % within EXPERIENCE RECODE | 18.2% | 17.5% | 5.1% | 16.1% |
| | | % of Total | 8.0% | 7.3% | .7% | 16.1% |
| | HIGH SCHOOL | Count | 33 | 25 | 6 | 64 |
| | | % within LEVEL OF EDUCATION | 51.6% | 39.1% | 9.4% | 100.0% |
| | | % within EXPERIENCE RECODE | 27.3% | 21.9% | 15.4% | 23.4% |
| | | % of Total | 12.0% | 9.1% | 2.2% | 23.4% |

| | | | | | | |
|---|---|---|---|---|---|---|
| | UNIVERSITY | Count | 41 | 21 | 4 | 66 |
| | | % within LEVEL OF EDUCATION | 62.1% | 31.8% | 6.1% | 100.0% |
| | | % within EXPERIENCE RECODE | 33.9% | 18.4% | 10.3% | 24.1% |
| | | % of Total | 15.0% | 7.7% | 1.5% | 24.1% |
| | OTHER | Count | 3 | 8 | 4 | 15 |
| | | % within LEVEL OF EDUCATION | 20.0% | 53.3% | 26.7% | 100.0% |
| | | % within EXPERIENCE RECODE | 2.5% | 7.0% | 10.3% | 5.5% |
| | | % of Total | 1.1% | 2.9% | 1.5% | 5.5% |
| Total | | Count | 121 | 114 | 39 | 274 |
| | | % within LEVEL OF EDUCATION | 44.2% | 41.6% | 14.2% | 100.0% |
| | | % within EXPERIENCE RECODE | 100.0% | 100.0% | 100.0% | 100.0% |
| | | % of Total | 44.2% | 41.6% | 14.2% | 100.0% |

**Chi-Square Tests**

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 38.620[a] | 10 | .000 |
| Likelihood Ratio | 39.606 | 10 | .000 |
| Linear-by-Linear Association | 16.392 | 1 | .000 |
| N of Valid Cases | 274 | | |

a. 1 cells (5.6%) have expected count less than 5. The minimum expected count is 2.14.

**Symmetric Measures**

| | | Value | Approx. Sig. |
|---|---|---|---|
| Nominal by Nominal | Phi | .375 | .000 |
| | Cramer's V | .265 | .000 |
| N of Valid Cases | | 274 | |

## 2.4 Farm Type and Ownership Structure

**Case Processing Summary**

| | Cases | | | | | |
|---|---|---|---|---|---|---|
| | Valid | | Missing | | Total | |
| | N | Percent | N | Percent | N | Percent |
| FARM TYPE * OWNERSHIP | 267 | 96.4% | 10 | 3.6% | 277 | 100.0% |

**FARM TYPE * OWNERSHIP Crosstabulation**

| | | | OWNERSHIP | | | Total |
|---|---|---|---|---|---|---|
| | | | OWNER | TENANT | OTHER | |
| FARM TYPE | DAIRY | Count | 1 | 0 | 0 | 1 |
| | | % within FARM TYPE | 100.0% | .0% | .0% | 100.0% |
| | | % within OWNERSHIP | .5% | .0% | .0% | .4% |
| | | % of Total | .4% | .0% | .0% | .4% |
| | LIVESTOCK | Count | 10 | 0 | 1 | 11 |
| | | % within FARM TYPE | 90.9% | .0% | 9.1% | 100.0% |
| | | % within OWNERSHIP | 4.5% | .0% | 2.4% | 4.1% |
| | | % of Total | 3.7% | .0% | .4% | 4.1% |
| | HORTICULTURE | Count | 53 | 2 | 27 | 82 |
| | | % within FARM TYPE | 64.6% | 2.4% | 32.9% | 100.0% |
| | | % within OWNERSHIP | 23.9% | 66.7% | 64.3% | 30.7% |
| | | % of Total | 19.9% | .7% | 10.1% | 30.7% |
| | MIXED | Count | 155 | 1 | 13 | 169 |
| | | % within FARM TYPE | 91.7% | .6% | 7.7% | 100.0% |
| | | % within OWNERSHIP | 69.8% | 33.3% | 31.0% | 63.3% |
| | | % of Total | 58.1% | .4% | 4.9% | 63.3% |
| | OTHER | Count | 3 | 0 | 1 | 4 |
| | | % within FARM TYPE | 75.0% | .0% | 25.0% | 100.0% |
| | | % within OWNERSHIP | 1.4% | .0% | 2.4% | 1.5% |
| | | % of Total | 1.1% | .0% | .4% | 1.5% |
| Total | | Count | 222 | 3 | 42 | 267 |
| | | % within FARM TYPE | 83.1% | 1.1% | 15.7% | 100.0% |
| | | % within OWNERSHIP | 100.0% | 100.0% | 100.0% | 100.0% |
| | | % of Total | 83.1% | 1.1% | 15.7% | 100.0% |

**Chi-Square Tests**

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 29.927[a] | 8 | .000 |
| Likelihood Ratio | 28.187 | 8 | .000 |
| Linear-by-Linear Association | 16.593 | 1 | .000 |
| N of Valid Cases | 267 | | |

a. 10 cells (66.7%) have expected count less than 5. The minimum expected count is .01.

**Symmetric Measures**

| | | Value | Asymp. Std. Error[a] | Approx. T[b] | Approx. Sig. |
|---|---|---|---|---|---|
| Nominal by Nominal | Phi | .335 | | | .000 |
| | Cramer's V | .237 | | | .000 |
| Interval by Interval | Pearson's R | -.250 | .062 | -4.199 | .000[c] |
| Ordinal by Ordinal | Spearman Correlation | -.260 | .063 | -4.387 | .000[c] |
| N of Valid Cases | | 267 | | | |

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

## 2.5 Farm Type and Responsibility for Decision Making

**Case Processing Summary**

| | Cases | | | | | |
|---|---|---|---|---|---|---|
| | Valid | | Missing | | Total | |
| | N | Percent | N | Percent | N | Percent |
| FARM TYPE * RESPONSIBILITY FOR DECISION MAKING | 268 | 96.8% | 9 | 3.2% | 277 | 100.0% |

**FARM TYPE * RESPONSIBILITY FOR DECISION MAKING Crosstabulation**

| | | | RESPONSIBILITY FOR DECISION MAKING | | |
|---|---|---|---|---|---|
| | | | YES | NO | Total |
| FARM TYPE | DAIRY | Count | 1 | 0 | 1 |
| | | % within FARM TYPE | 100.0% | .0% | 100.0% |
| | | % within RESPONSIBILITY FOR DECISION MAKING | .4% | .0% | .4% |
| | | % of Total | .4% | .0% | .4% |
| | LIVESTOCK | Count | 8 | 3 | 11 |
| | | % within FARM TYPE | 72.7% | 27.3% | 100.0% |
| | | % within RESPONSIBILITY FOR DECISION MAKING | 3.1% | 30.0% | 4.1% |
| | | % of Total | 3.0% | 1.1% | 4.1% |
| | HORTICULTURE | Count | 82 | 2 | 84 |
| | | % within FARM TYPE | 97.6% | 2.4% | 100.0% |
| | | % within RESPONSIBILITY FOR DECISION MAKING | 31.8% | 20.0% | 31.3% |
| | | % of Total | 30.6% | .7% | 31.3% |
| | MIXED | Count | 163 | 5 | 168 |
| | | % within FARM TYPE | 97.0% | 3.0% | 100.0% |
| | | % within RESPONSIBILITY FOR DECISION MAKING | 63.2% | 50.0% | 62.7% |
| | | % of Total | 60.8% | 1.9% | 62.7% |
| | OTHER | Count | 4 | 0 | 4 |
| | | % within FARM TYPE | 100.0% | .0% | 100.0% |
| | | % within RESPONSIBILITY FOR DECISION MAKING | 1.6% | .0% | 1.5% |
| | | % of Total | 1.5% | .0% | 1.5% |
| Total | | Count | 258 | 10 | 268 |
| | | % within FARM TYPE | 96.3% | 3.7% | 100.0% |
| | | % within RESPONSIBILITY FOR DECISION MAKING | 100.0% | 100.0% | 100.0% |
| | | % of Total | 96.3% | 3.7% | 100.0% |

**Chi-Square Tests**

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 17.858[a] | 4 | .001 |
| Likelihood Ratio | 8.602 | 4 | .072 |
| Linear-by-Linear Association | 2.758 | 1 | .097 |
| N of Valid Cases | 268 | | |

a. 6 cells (60.0%) have expected count less than 5. The minimum expected count is .04.

**Symmetric Measures**

| | | Value | Asymp. Std. Error[a] | Approx. T[b] | Approx. Sig. |
|---|---|---|---|---|---|
| Nominal by Nominal | Phi | .258 | | | .001 |
| | Cramer's V | .258 | | | .001 |
| Interval by Interval | Pearson's R | -.102 | .077 | -1.666 | .097[c] |
| Ordinal by Ordinal | Spearman Correlation | -.094 | .074 | -1.532 | .127[c] |
| N of Valid Cases | | 268 | | | |

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

## 2.6 Farm Annual turnover and Agricultural Regions

**Case Processing Summary**

| | Cases | | | | | |
|---|---|---|---|---|---|---|
| | Valid | | Missing | | Total | |
| | N | Percent | N | Percent | N | Percent |
| TURNOVER * AGRICULTURAL REGIONS | 267 | 96.4% | 10 | 3.6% | 277 | 100.0% |

**TURNOVER * AGRICULTURAL REGIONS Crosstabulation**

| | | | AGRICULTURAL REGIONS | | | Total |
|---|---|---|---|---|---|---|
| | | | AL-GABAL AL-AKDER | ALJAFARA | FAZZAN | |
| TURNOVER | 1000-29000 | Count | 86 | 79 | 85 | 250 |
| | | % within TURNOVER | 34.4% | 31.6% | 34.0% | 100.0% |
| | | % within AGRICULTURAL REGIONS | 87.8% | 98.8% | 95.5% | 93.6% |
| | | % of Total | 32.2% | 29.6% | 31.8% | 93.6% |
| | 30000-+ | Count | 12 | 1 | 4 | 17 |
| | | % within TURNOVER | 70.6% | 5.9% | 23.5% | 100.0% |
| | | % within AGRICULTURAL REGIONS | 12.2% | 1.3% | 4.5% | 6.4% |
| | | % of Total | 4.5% | .4% | 1.5% | 6.4% |
| Total | | Count | 98 | 80 | 89 | 267 |
| | | % within TURNOVER | 36.7% | 30.0% | 33.3% | 100.0% |
| | | % within AGRICULTURAL REGIONS | 100.0% | 100.0% | 100.0% | 100.0% |
| | | % of Total | 36.7% | 30.0% | 33.3% | 100.0% |

**Chi-Square Tests**

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 9.717[a] | 2 | .008 |
| Likelihood Ratio | 10.275 | 2 | .006 |
| Linear-by-Linear Association | 4.937 | 1 | .026 |
| N of Valid Cases | 267 | | |

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 5.09.

**Symmetric Measures**

| | | Value | Approx. Sig. |
|---|---|---|---|
| Nominal by Nominal | Phi | .191 | .008 |
| | Cramer's V | .191 | .008 |
| N of Valid Cases | | 267 | |

## 2.7 Farm Annual Turnover and How Many People Manage the Farm

**Case Processing Summary**

| | Cases | | | | | |
|---|---|---|---|---|---|---|
| | Valid | | Missing | | Total | |
| | N | Percent | N | Percent | N | Percent |
| TURNOVER4 * HOW MANY PEOPLE MANAGE FARM RECODE | 211 | 76.2% | 66 | 23.8% | 277 | 100.0% |

**TURNOVER4 * HOW MANY PEOPLE MANAGE FARM RECODE Crosstabulation**

| | | | HOW MANY PEOPLE MANAGE FARM RECODE | | Total |
|---|---|---|---|---|---|
| | | | 1-6 | 7-12 | |
| TURNOVER4 | 1000-29000 | Count | 185 | 9 | 194 |
| | | % within TURNOVER4 | 95.4% | 4.6% | 100.0% |
| | | % within HOW MANY PEOPLE MANAGE FARM RECODE | 94.4% | 60.0% | 91.9% |
| | | % of Total | 87.7% | 4.3% | 91.9% |
| | 30000+ | Count | 11 | 6 | 17 |
| | | % within TURNOVER4 | 64.7% | 35.3% | 100.0% |
| | | % within HOW MANY PEOPLE MANAGE FARM RECODE | 5.6% | 40.0% | 8.1% |
| | | % of Total | 5.2% | 2.8% | 8.1% |
| Total | | Count | 196 | 15 | 211 |
| | | % within TURNOVER4 | 92.9% | 7.1% | 100.0% |
| | | % within HOW MANY PEOPLE MANAGE FARM RECODE | 100.0% | 100.0% | 100.0% |
| | | % of Total | 92.9% | 7.1% | 100.0% |

**Chi-Square Tests**

| | Value | df | Asymp. Sig. (2-sided) | Exact Sig. (2-sided) | Exact Sig. (1-sided) |
|---|---|---|---|---|---|
| Pearson Chi-Square | 22.243[a] | 1 | .000 | | |
| Continuity Correction[b] | 17.843 | 1 | .000 | | |
| Likelihood Ratio | 13.300 | 1 | .000 | | |
| Fisher's Exact Test | | | | .000 | .000 |
| Linear-by-Linear Association | 22.137 | 1 | .000 | | |
| N of Valid Cases | 211 | | | | |

a. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 1.21.

b. Computed only for a 2x2 table

**Symmetric Measures**

| | | Value | Approx. Sig. |
|---|---|---|---|
| Nominal by Nominal | Phi | .325 | .000 |
| | Cramer's V | .325 | .000 |
| N of Valid Cases | | 211 | |

## 2.8 Farm Annual Turnover and Farm Size

**Case Processing Summary**

| | Cases | | | | | |
|---|---|---|---|---|---|---|
| | Valid | | Missing | | Total | |
| | N | Percent | N | Percent | N | Percent |
| TURNOVER4 * Farm Size Record | 256 | 92.4% | 21 | 7.6% | 277 | 100.0% |

**TURNOVER4 * Farm Size Record Crosstabulation**

| | | | Farm Size Record | | Total |
|---|---|---|---|---|---|
| | | | 5-37 | 38-60+ | |
| TURNOVER4 | 1000-29000 | Count | 223 | 17 | 240 |
| | | % within TURNOVER4 | 92.9% | 7.1% | 100.0% |
| | | % within Farm Size Record | 95.3% | 77.3% | 93.8% |
| | | % of Total | 87.1% | 6.6% | 93.8% |
| | 30000+ | Count | 11 | 5 | 16 |
| | | % within TURNOVER4 | 68.8% | 31.3% | 100.0% |
| | | % within Farm Size Record | 4.7% | 22.7% | 6.3% |
| | | % of Total | 4.3% | 2.0% | 6.3% |
| Total | | Count | 234 | 22 | 256 |
| | | % within TURNOVER4 | 91.4% | 8.6% | 100.0% |
| | | % within Farm Size Record | 100.0% | 100.0% | 100.0% |
| | | % of Total | 91.4% | 8.6% | 100.0% |

**Chi-Square Tests**

| | Value | df | Asymp. Sig. (2-sided) | Exact Sig. (2-sided) | Exact Sig. (1-sided) |
|---|---|---|---|---|---|
| Pearson Chi-Square | 11.152[a] | 1 | .001 | | |
| Continuity Correction[b] | 8.288 | 1 | .004 | | |
| Likelihood Ratio | 7.381 | 1 | .007 | | |
| Fisher's Exact Test | | | | .007 | .007 |
| Linear-by-Linear Association | 11.109 | 1 | .001 | | |
| N of Valid Cases | 256 | | | | |

a. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 1.38.

b. Computed only for a 2x2 table

**Symmetric Measures**

| | | Value | Approx. Sig. |
|---|---|---|---|
| Nominal by Nominal | Phi | .209 | .001 |
| | Cramer's V | .209 | .001 |
| N of Valid Cases | | 256 | |