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Effect of Farmer Experience on Selection of Irrigation Methods at Sirte, Libya

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Abstract: Water is the most important basic need for all aspects of human and ecosystem survival. This study aims to show the preferred method of irrigation among the farmers at Jarif–Sirte site, Libya. It was carried out over a three week period, between 17th June and 9th July 2010.The methods of irrigation were divided into modern methods (sprinkler and drip systems) and traditional (surface systems-basin and furrow). Water productivity (WP) and profitability were the most important points that were covered. Two main methods for gathering data were used; the first one was a questionnaire and the second was a focus group, also known as group discussion. The results indicated that adopting modern irrigation systems, especially drip irrigation, can improve WP and profitability dramatically, whereas, water use can be reduced by at least one third with similar productivity for the other systems. Several factors which influence adoption of advanced technologies have been noted in this study. Whereas the educated farmers tend to adopting modern irrigation methods instead of traditional methods. Moreover, economic factors are the main barrier to adoption as well as the fact that there will be no obligation to pay the high cost of the electricity and water bills associated with the traditional methods. The study recommend that famers should switch to modern systems. Future studies should be carried out on the site for further information.

Key Words: irrigation systems; water productivity; profitability; focus group

INTRODUCTION

It is generally acknowledged that water is a vital resource, essential for all aspects of human and ecosystem survival. Water was the main cause of the movement of human societies in the past, with groups settling only in areas where a water source was present. Early civilizations were therefore established around sources of water. Agriculture is the largest consumer of water, taking one hundred times more than that needed for personal use. Over 70% of the water obtained from rivers and groundwater goes into irrigation, with 10% used for domestic applications and 20% for industry (Leib, 2003).

The history of irrigation goes back several thousand years. In the Far East, for example, rice has been grown using irrigation for almost five thousand years; while in Iraq and the Nile delta in Egypt, irrigation was used around four thousand years ago (Stern, 1979). Irrigation systems can be divided into two main groups i.e traditional and modern systems (Turral *et al*., 2010). Surface irrigation systems known as flood irrigation, such as furrow and basin are the most ancient types of irrigation technology. The modern irrigation technology firstly were used in India throughout the 19^{th} century, and followed by large-scale in some parts of the United States (Stern, 1979). During the 20^{th} century and the beginning of the 21^{st} century, several types of modern systems have been developed, such as sprinkle and drip irrigation. Each type aims to minimize the effect of water as the production-limiting factor, and reducing excessive application. Although there are new irrigation systems, traditional methods are still used in many countries around the world, (Turral *et al.*, 2010).

As a result of growing populations, the demand for irrigation and drinking water is expected to increase by 20% over the next 25 years. Since most developing countries' economies depend on agriculture, a shortage of freshwater can lead to food shortages in several regions of the world. In addition, improper management of water resources has reduced crop production to a large extent, damaged soil texture considerably, and dissipates the amount of water used (ISESCO, 2010). Consequently, a good management of water resources is very essential to solve water problems.

Libya is a North African country bordered by the Mediterranean Sea to the north, Egypt and Sudan to the east, Niger, Chad and Sudan to the south, and Algeria and Tunisia to the west. It has a total area of 1,759,540 km^2. The population of Libya increased from less than 1million in 1955 to 6 million in 2006, and it is estimated to reach up to 12 million by 2025. It is estimated that 14% of Libya population work in the agricultural sector (Alghariani, 2010).

Overall Gross Domestic Product was US$19100 million in 2002 with an approximate growth rate of 3.2 % per year. It has grown to US$ 58333 million in 2007, with a growth rate of more than 5%. The Libyan economy depends mainly on revenues from the oil sector, whereas agriculture contributes about 9% of the Gross Domestic Product (GDP), (National Investment Brief of Libyan Arab Jamahiriya, 2008).
Annual precipitation is extremely low, with about 93 percent of the land surface receiving less than 100 mm/year. The highest rainfall takes place in the northern Tripoli region and in the northern Benghazi region. These two regions being the only ones where the mean annual precipitation exceeds the minimum value (250-300 mm) considered necessary to sustain rainfed agriculture (National Investment Brief of Libyan Arab Jamahiriya, 2008).

Suitable land for cultivation is estimated at 2.2 million ha, of which 239,000 ha are dedicated to irrigated agriculture and 1.55 million ha to rainfed farming. About 14 million ha comprise forest and range lands. The chief agricultural products of Libya are cereals (wheat, barley and Alfalfa), legumes, vegetable, fruits, meat and dairy products (Azzabi, 2010).

In Libya there are no significant surface water resources available (roughly 99 % of cultivated land is irrigated using groundwater, while the remaining 1 % is irrigated by treated wastewater and surface water), therefore groundwater is the main source of water. To face these water problems, the Libyan government has started a large project known as The Great Man Made River Project (GMMRP), designed to transfer fresh water from its southern regions to its northern regions (Eljadid, 2009). The project has given famers the opportunity to cultivate their fields and increase the area of agricultural land in the northern regions.

On almost the entire area sprinkler irrigation is practised, due to the sandy soils prevailing in most areas of the country. The costs of installing sprinkler irrigation systems on a farm amount to about US$10,000/ha (National Investment Brief of Libyan Arab Jamahiriya, 2008).

Modernization of irrigation has been defined as a fundamental transformation of the management of irrigation water resources, aiming to improve the utilization of resources and the service provided to farmers. Modernization of irrigation systems should take place to show growers how they can save water and get high yields using modern irrigation systems (Playan and Mateos, 2006).

The emphasis of education as a driving force for the growth of agricultural productivity can be dated back to the early 1960s, Huang and Luh (2009). The production function approach has produced evidence of a link between education and agricultural output in the developing world literature. Lockheed, *et al*. (1980) reviewed 18 studies representing 37 data sets (primarily in Asia) and found that most reported a significant positive effect of education upon output. They noted that a significant positive relationship was more likely to be found in areas where farmers are modernizing.

Comparison of irrigation methods is complicated. However, successful irrigation of agricultural lands relies upon choosing the most suitable irrigation method for the soil, climate, water resources, topography, plants, economic and social conditions, as well as the farmer's requirements (Mehmet and Bigak, 2002). Many studies have been carried out to evaluate the effect of some factors such as soil, crop, water source and cost on selection of an irrigation system. But the experience of farmer in selection of an irrigation system always ignored in such countries like Libya. Therefore, the overall aim of this study was to examine the adopting of modern irrigation systems instead of traditional irrigation systems according to the experience of farmers in the Sirte, Libya.

METHODOLOGY

Study site

The region of Sirte is an essential Libyan agricultural area located at a 31.2° N, 16.6° E, and 13 m above m.s.l. It spans 450 km of the coast, with

a total area of 69 km^2. The region consists of over ten agricultural valleys that have been cultivated since the 1970s. The climate is characterized by mild winter and warm summer, with minimum temperature of 6 to 18˚C and maximum temperature of 20 -30˚C, and average annual rainfall is 180 mm.

The present study was conducted at the Jarif site of Sirte. The site consists of around 505 farms but the study randomly selected 230 farms to represent the site. The site is characterized by an almost flat slope; soil is non-saline, non-alkaline, low fertility, low organic matter, light texture and deep profile. Generally it was classified as Entisols and Aridsols (Abdulaziz, 2008).

METHODS

Two main methods were used to gather data from the site (Jarif). The first method used was a questionnaire, which is a quantitative method, while the second was a focus group, which is a qualitative method. The reason for choosing these two methods was that each one has its own strengths and weaknesses. For example, a questionnaire can provide a large amount of information in a short time, although the data collected can have a low reliability rate. A focus group can give people the opportunity to air their opinions without having to provide only yes or no answers. Using both methods can provide complimentary results that are better than those provided by only one method. The data was gathered over a three week period, between 17th June and 09th July 2010. Data was input into excel sheet. Then data was processed and compared with each other's, and then it layouts in clear tables and figures.

Questionnaire

The primary method of gathering data in this project was a questionnaire. It was distributed to 50 farmers. It was given to 25 farmers who have adopted modern techniques of irrigation like sprinkle and drip irrigation systems, and 25 farmers who still use traditional irrigation systems such as flooding. The questionnaire was divided into three main sections. The first section was about personal information such as age and education. In this case three categories were developed: 21-30 years, 31-40 years, and more than 40 years. Level of education was also included in this section

because it may play a role in the outlook of the farmer with regards to modern irrigation technology. The second section was about the farm itself, requesting information like the type of irrigation systems, water used and the major crops grown on the farm. The last part was about the irrigation system used and the productivity of the farm.

Focus group

The second technique used for collection of information in this project was a focus group (or group discussion). This method helps to obtain information and opinions from participants. In addition, it can cover information that may have been missed by the first method. Several points were covered in the group discussion, such as reasons for using old methods or adopting modern systems, and the opinions of the farmers about modern technology and how they have improved their productivity by using such systems. This technique was conducted on two focus groups: one group consisted of farmers who had changed to modern irrigation (group A), and the other consisted of farmers who had continued to use old methods of irrigation (group B). Each group has six farmers participated in the discussion.

RESULTS

The most important questions in the questionnaire have been illustrated using frequency tables or graphs to give an overview of the data. As shown in the Fig.1 half of the studied farmers were over forty years old, while farmers in the range of 31-40 years old recorded 34% of the participants and those between20-30 years old accounted only for 16%.

The results of the education level question showed that farmers who have been educated at high school and above represented 46% of the participants, educated to intermediate school level or less, recorded 44% and illiterate farmers were in a minority, at 10%. On the other hand, 60% of modern irrigation users are high school or above educated, and the percentage decreased when level of education is lowered. The percentage of illiterates farmers who are using modern irrigation systems are very low, while the percentage increased with traditional irrigation adoption (Fig. 2).

Table 1 shows the agricultural experience of farmers. It can be clearly seen that nearly half of the farmers have more than 10 years' experience, while the same percentage (26%) of famers have experience of 6-10 years and. less than 5 years.

The results show that around 85% of participants are not members of any agricultural organization, but the remaining participants are members.
Regarding using labourers, 66% of the surveyed famers answered yes, while 34% said they have not used labourers. In addition, the result highlighted that 100% of the farmers who answered yes, just used 2 or less full-time labourers. Fig. 3 presents the percent of workers used in both systems. It can be seen that the majority of workers were used with the traditional irrigation systems as compared with those used with modern irrigation systems.

As shown in Fig. 4 the modern irrigation methods were adopted in small areas less than 4 ha, but for area of 4 ha or more farmers tend to use the traditional methods.

It was observed that in the whole studied areas, olive trees represent the common crop, followed by vegetables and fodder crops, respectively. The study found that olive trees/ vegetables always irrigated using traditional methods more than modern methods, and vice versa for olive/fodder crops.

Fig. 6 shows that surface irrigation systems are the most commonly used systems (40%), followed by Sprinkler and drip systems (22% and 12%), respectively. While in combination between two systems sprinkler/ drip were used more than sprinkler/surface.

The Fig. 7 shows that most farmers who adopted modern irrigation systems are satisfied or very happy with the profitability and amount of water used, whilst a small number of farmers are moderately satisfied.

Results of group discussion

The structure of the focus group was explained to the participants to give them a clear idea of the points that the discussion would cover. Then, farmers in each group were asked about certain issues related to irrigation

systems, such as their background, in order to open the discussion. Farmers in each group had basic knowledge about the systems. However, information about new irrigation systems and technologies that are delivered by modern users (group A) was more reliable. For instance, they had good background knowledge about the problem of plugged filters, the price of filters, and their disadvantages. When the point was raised about the need for knowledge and skills when using drip irrigation, both group A and B gave the same opinion, that drip irrigation systems are easy to set up and they have no need for extra skills. Both groups are agreed that diseases such as Powdery Mildew and Epilachnachrysomelina in watermelon occur when using traditional systems. They added that most diseases come from wind, dust and humidity, and when adopting modern systems, especially sprinkler systems, most of these diseases can be reduced because sprinkled water can wash away the dust.

The cost of agricultural operations such as preparing beds for seeding was discussed. Farmers in both groups who still use traditional systems stated that most of the agricultural operations are costly when compared with modern irrigation systems.

Concerning the water use efficiency (WUE), which was mentioned in an easy way so that the farmers would understand it such as talking about the amount of water that is used in both systems and the yield that is achieved, the answer given by group A was clearer than that given by group B. Group A said that modern systems, particularly drip irrigation, can provide high productivity with less water use. They supported this view with an example, that the amount of water used for irrigating one hectare can be used to irrigate three hectares, and also with sprinkler systems the rate of water used is less than with surface systems.

Farmers' income was discussed by the focus group. Both groups agreed that modern and traditional systems can recover costs and provide a good income for users, but they directed attention to the others factors that affected agricultural income such as market forces.

When the discussion reached the factors that affect the selection of an irrigation system, group A stated clearly that it is not easy to know all the factors that influence choosing a system, but they did say that in addition

to the number of labourers and the method of adding fertilizers, and costs of setting up the system play a central role. While, group B added two factors which are soil and crop type.

DISCUSSION

The looming water crisis in Libya necessitates immediate action to reduce the agricultural demand that consumes up to 80% of the water supplies. This study aimed to examine the selection of irrigation systems according to experience of farmers at the Jarif site, Sirte, Libya. Within the study site both modern and traditional irrigation methods are widely used. Results of the study showed that the age of the majority of the farmers are lied at the category more than forty, and this considered as optimum age for farming work, as stated by Aballah (2011). Also the results showed that the level of education of farmers in the site is high, with around 50% of farmers being high school educated. This finding supports a report of the Ministry of Education in Libya which states that the level of illiterates in Libya stands at around 11%, most of whom are women and elderly people. Also, the results of the questionnaire revealed that level of education can affect the selection of irrigation system. The questionnaire results agreed with finding of Appleton and Balihuta (1996), whose stated that education may boost the aptitude to acquire the information about new technology, enables farmers to do the job more efficiently and complement to farm experience in farm output.

In contrast, the group discussion highlighted that there is no relationship between education level and choosing an irrigation system. One of the famers gave the reason for this, namely that word of mouth is one of the most common methods used for finding out information about new types of irrigation, rather than education.

The type of irrigation system was associated strongly with the designer of the system. This finding was made in both methods of gathering data, especially the focus group when the issue of setting up a system was discussed. Farmers stated that designers sometimes take around 1500 (1000$) Libyan Dinar (DR) to design a system; therefore, they prefer to do it by themselves. This result agreed with the finding of Mantovani *et al*. (1995) and Ali and Talukder (2008), whose stated that economic

factors like the fixed and operational costs of irrigation systems highly influence water profitability. Another positive point that accounted to modern irrigation systems against traditional irrigation systems is adding fertilizer with irrigation water, which leads to improve water profitability. This finding is supported by Sharmasarkar *et al.* (2001) and Mehmet and Bigak (2002).

Labour uses under modern systems is less intensive than traditional methods. This point was argued by group B in relation to the need for workers to move sprinklers laterals. However, Smethers *et al.* (1993) stated that surface irrigation requires more labour, Keller and Bliesner (1990) reported that one of the main benefits of sprinkler irrigation is the saving of labour, and Mehmet and Bigak (2002) observed that drip irrigation requires very few workers. WUE in advanced systems is usually higher than that in traditional methods. The farmers in the group discussion completely agreed that water used in the surface method is more by three or four times than that used with modern irrigation systems. Several studies have found the same finding. Bernstein and Francois (1973) found that drip irrigation systems used one-third of the water or less than furrow. Varshney (1995) reported that advanced technologies consume half of the water rate per hectare than less advanced methods. Al-Jamal *et al.* (2001) found WUE using a sprinkler system was high compared to the furrow irrigation methods. on the other hand the results revealed the using of modern irrigation system decreased when farm area increased, and this may be attributed to the initial cost, which is considered higher in modern systems than that for surface irrigation. Also may be due to the complication in modern irrigation systems network when area increased.

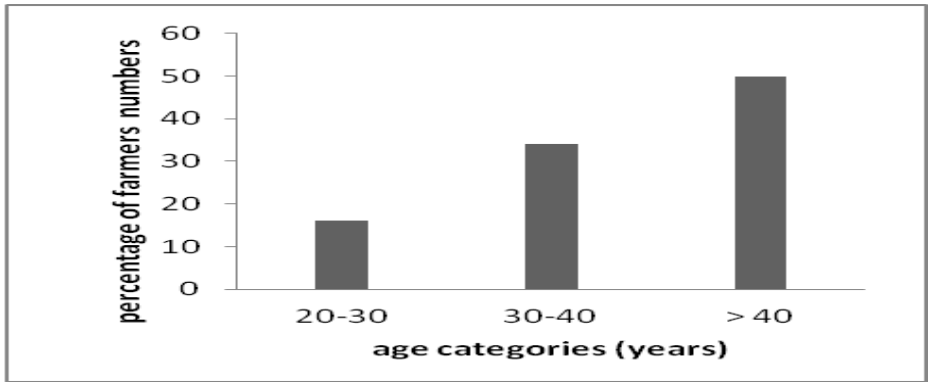

Fig. 1 Age categories of the farmers in the groups

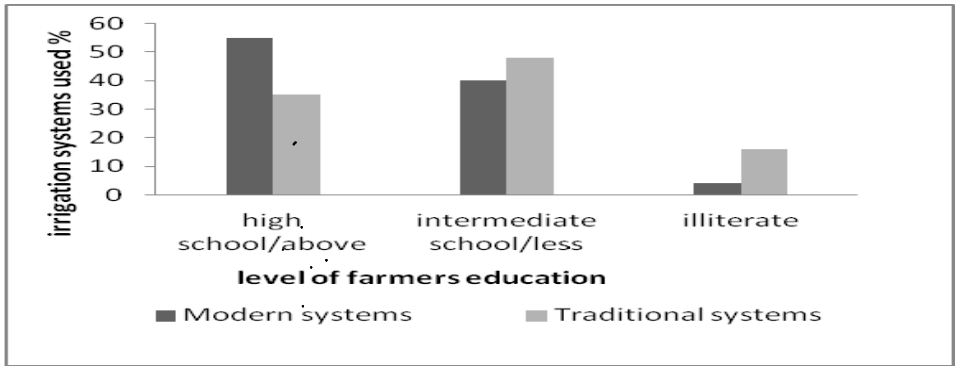

Fig. 2 The using of irrigation systems according to the level of farmers education

Table 1. Farmers Experience in Agriculture

Experience years	frequency	Percent %
≤5	13	26
6-10	13	26
≥10	24	48
Total	50	100

Table 2. Number of labourers used

	Frequency	Percent
No	17	34.0
Yes	33	66.0
Total	50	100.0

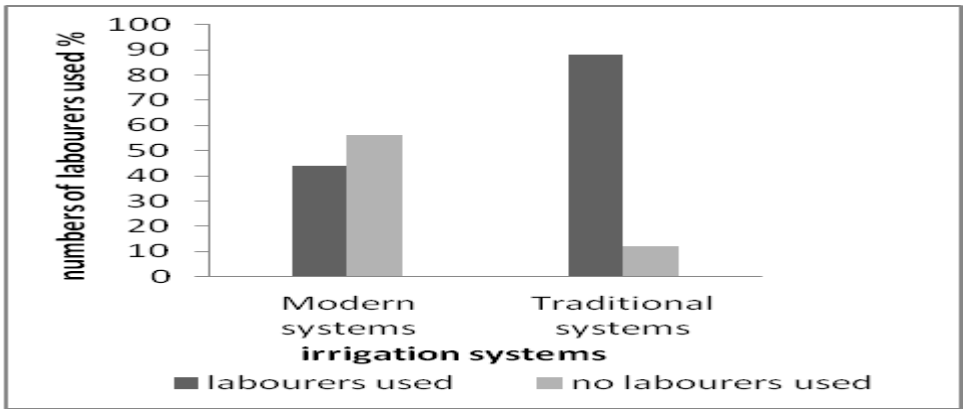

Fig. 3. Numbers of labourers used/non-used in each method

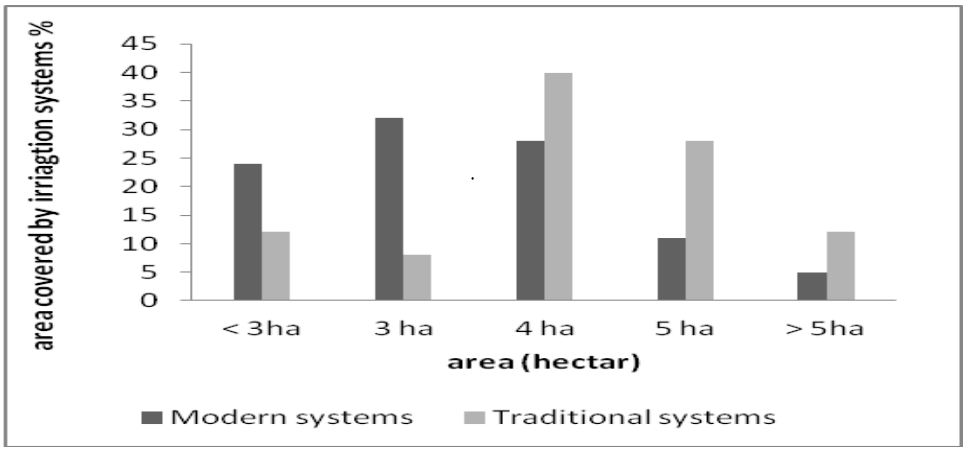

Fig. 4. cultivated area under irrigation systems

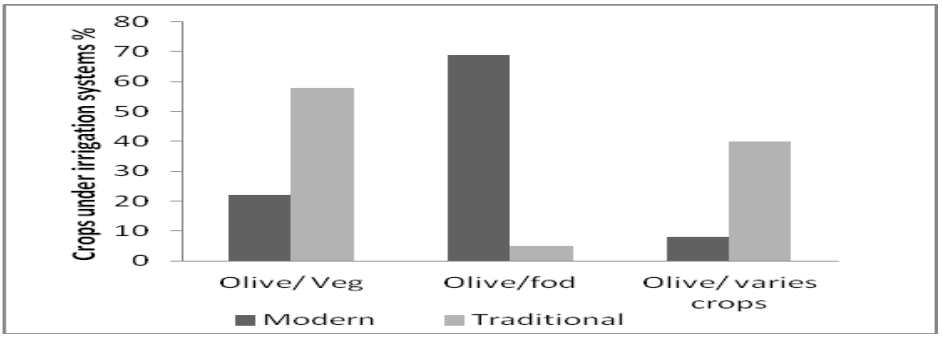

Fig. 5. Main crops grown under both systems

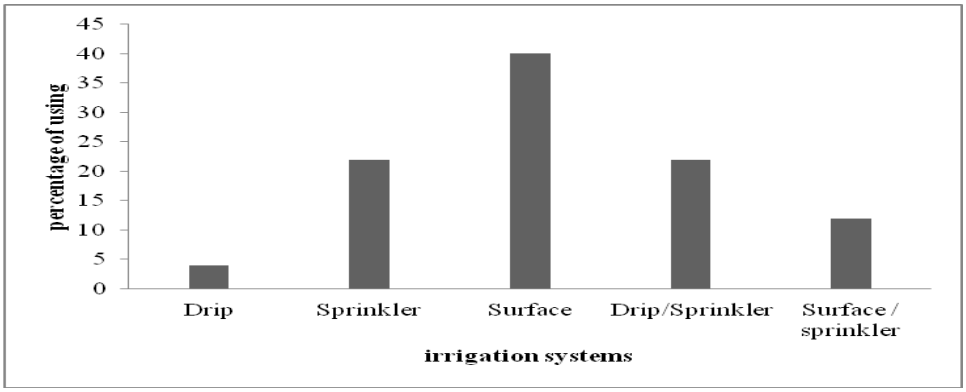

Fig. 6. the type of irrigation systems used by Sirte farmers

Fig. 7. satisfactions of farmers from profitability and water use of modernirrigation systems.

CONCLUSIONS

1. In general, adopting advanced technology for irrigation can increase water productivity (WP) within the site.
2. Improving the farmers level of education will affect positively on adopting the new irrigation technology.
3. The age categories of farmers are varied but the majority of them under the category above 40 year.
4. Further studies for long period are highly needed to provide confidential data to improve the agricultural sector in the region.
5. Training courses to improve the farmers' knowledge is an essential factor that should be considered in the future programmes.

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تأثير خبرة المزارع علي اختيار طرق الري في سرت- ليبيا

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المستخلص: الماء من الضروريات الأساسية لبقاء الأنسان و النظام البيئي. هدفت هذه الدراسة لمعرفة طرق الري المفضلة لدي مزارعي الجارف في ناحية سرت ليبيا. أجريت الدراسة علي مدى ثلاثة أسابيع في الفترة من 17 يونيو إلي 9 يوليو 2010 . قسمت طرق الري إلي طرق ري حديثة (ري بالرش و ري بالتنقيط) و طرق ري تقليدية (ري سطحي حوضي و بالأخاديد). كانت إنتاجية الماء وعائدها أهم النقاط التي تمت تغطيتها. استخدمت طريقتين أساسيتين لتجميع البيانات, حيث كانت الأولي عبارة عن استبيان و الثانية مجموعة مركزية تعرف أيضا بمجموعة النفاش. أشارت النتائج إلي أن تبني الطرق الحديثة و خاصة الري بالتنقيط يحسن من إنتاجية وربحية الماء بصورة ملحوظة، حيث نقص الماء المستخدم بنسبة الثلث لنفس إنتاجية الأنظمة الأخرى. عدة عوامل مؤثرة علي تبني التقنيات المتقدمة تم الإشارة إليها في هذه الدراسة. حيث مال المزارعين المتعلمين لتبني نظم الري الحديثة بدلا عن النظم التقليدية. أيضا كانت العوامل الاقتصادية العائق الرئيسي للتبني، إضافة إلي عدم الالتزام بدفع تكاليف الكهرباء و الماء المستخدمة للري التقليدي. توصي هذه الدراسة بتبني الأنظمة الحديثة و اجراء الدراسات المستقبلية في الموقع للمزيد من المعلومات.