J. Agric. Econom. and Social Sci., Mansoura Univ., Vol.4 (6): 1107 - 1118, 2013

FARMERS' IRRIGATION BEHAVIOR UNDER IMPROVED AND UNIMPROVED IRRIGATION SYSTEMS IN BEHERA GOVERNORATE

Nawar, M. H. ; Azza T. El Bendary and A. N. El Sherbiny
Dept. of Rural Sociology and Agric. Extension, Fac. Agric., Cairo University, Giza, Egypt.

ABSTRACT

This study aims to compare some aspects of the efficiency and effectiveness of the irrigation process under the two conditions of the improved and unimproved irrigation systems. The study was conducted in Behera governorate where the Irrigation Improvement Projects (IIPs) have been applied in the domain area of El-Mahmoudia main canal. Three branch canals from the area covered by IIPs and another branch canal located in the areas not covered by IIPs were selected to represent the current situation of irrigation systems in both areas (improved and unimproved). Three *mesqas* were randomly selected from each branch canal taking into account the different locations of *mesqas* on the branch canals (Up-stream/Mid-stream/Down-stream).

A sample of 186 Water Users (WUs) was selected (125 from improved *mesqas* and 61 from unimproved ones) from all selected *mesqas* taking into consideration the location of water users (WUs) on each *mesqa* (Up-stream/Mid-stream/Down-stream). Data were collected through personal interviews by using two questionnaires (one for the farmers in the improved *mesqas* and one for unimproved *mesqas*).

Results revealed that: about 46.4% and 34.4% of the respondents in the improved and unimproved respectively reported that conflicts on irrigation water have "increased", while 76.2% and 29.3% respectively indicated that such conflicts were "always" solved. Surprisingly, 75.2% and 88.5% respectively reported that they "used" laser land leveling. Period used for irrigation was reported "less than before" by 52% and 27.9% respectively. The cost of irrigation was reported as "less than before" by 39.2% and 1.6% respectively. Quantity of irrigation water was considered "sufficient" by 60.85% and 11.5% respectively, while Differences were significant in the cases of conflicts resolutions, time needed for irrigation, costs of irrigation, and sufficiency of irrigation water.

As a conclusion of these results, improvement of the local irrigation management with its two physical and organizational components would help enhancing equity in distribution of irrigation water among the users and thus effectiveness of the local irrigation system.

Keywords: Irrigation behavior, Irrigation systems, Behera, Egypt

INTRODUCTION

The world is facing an escalating scarcity of water and land resources that is threatening the ability of agricultural sector to ensure global food security. Food supplies will not be secured without significant increases in the areas of irrigated land and efficiency of water use. Accordingly, to enhance the productivity of irrigated agriculture, a coherent strategy and plan to

optimize use of irrigation technology and management are needed (FAO, 2013).

Egypt is one of the countries that are in critical need for improving their irrigation system, since agriculture depends heavily on irrigation; which is allocated about 86% of all water resources (MWRI, 2013). Additionally, in the Nile Delta and Valley there is a very complicated network of water channels, for irrigation and drainage that exceeds 60 000 km in length which are comprised of various levels of canals conveying water to all end-users. (Nawar, 2008, p.13).

The research of Regional Irrigation Improvement Program (RIIP) was conducted in1989 to improve agricultural productivity and reduce water use in the old lands with users' involvement in irrigation management. RIIP had two main components; a) the physical changes included changing the operation of secondary system from rotational to continuous flow, rebuilding of existing tertiary canals (*Mesqas*), and replacing individual pumps by collective pumping, b) the organizational changes that included establishment of Water User Associations (WUAs) and the creation of an Irrigation Advisory Service (Kotb. T, & Boissevain, W, 2012). From the research it was concluded that improvement of the performance of irrigation water system was expected to increase the efficiency of irrigated agriculture water use and services, and thus to have positive impacts on the quality of supply (water distribution, quantity, quality, equity and timeliness) (IFAD, 2012).

Based on the outcome of this research, the Irrigation Improvement Project (IIP) was established in the early nineties of the last century. The IIP is made up of improved control structures using modern methods in land leveling/tillage, on-farm irrigation development, rehabilitation of main and branch canals and most of all *mesqas*, promoting equity of water distribution, and attaining a form of cooperation between the irrigation directorate and farmers by forming WUAs (Alnaggar, D. 2003). The physical improvement coincident with the reorganization process is based on establishment of one collective lifting point at the Up-stream of the improved *mesqa*; i.e. Polyvinylchloride (PVC) buried tube to replace all lifting points on the old open *mesqa*. This collective lifting point is managed by the WUA to represent the common interests of all WUs (WB, 2007).

In order to become fully operative and to achieve equal water distribution along the *mesqa* and increase farmer productivity, the IIP technical improvement package requires a relatively high level of social organization among farmers who need to manage communal pumping stations. The development of WUAs was therefore a social pre-requisite for technical innovations to become effective. Conventional social organization of farmers in irrigation process in the unimproved area was thus replaced by the WUA in the improved areas where farmers' perception of ownership of irrigation system is crucial to ensure sustainability of water use (Allam M.N, 2004, p. 125).

WUA's operational performance (organizational, technical, and financial) is affected by internal and external factors. The internal factors are represented by the regulations controlling management and the network of interrelationships among the members of associations while acting and using

the water allocated for their *mesqas*. This in turn, affects performance of the WUA and the irrigation process and its effectiveness. On the other hand, the external factors that affect WUAs' performance are expressed by contextual conditions of performance that lay outside the influence of the irrigation community or WUA (MWRI, 2005). Accordingly, any defect that may occur in the internal or external factors that control WUAs' performance may lead to dysfunction of the improvement projects and some degree or another of gap in achievement of their objectives. This finally, may affect the national level of objectives of water rational use; to solve the problem of water scarcity. Hence, the role of WUAs in rationalizing farmers' irrigation behavior will be the focus of this study.

Problem statement

Under the unimproved irrigation arrangements, it was found that there is a tendency to favor the farmers at the head of the water channels on the expenses of in tail farmers. This situation led in most cases to more conflicts over the irrigation water among farmers and further marginalization of the farmers located at the tail of water channels that affected their production and coping strategies to adapt to the situation of water limitation. Meanwhile, due to the unfair distribution of water, a significant part of other inputs are misused or abandoned which is against the national welfare. Hence, IIP with WUAs in the improved *mesqas* were designed to avoid such situation of unfair distribution of irrigation water and help rational use of both water and land resources that would lead to better socio-economic conditions of farmers and the rural population welfare thereafter.

Based on the above, the following questions have been provoked; to what extent the WUs have perceived change in the performance of their WUAs? Moreover, to what extent WUs have perceived the physical changes that happened on their *mesqas* by IIP, which are considered as external factors that could affect the performance of WUAs in improved areas. In contrast, is there any informal organizational form that aims to fair distribution of irrigation water among WUs in unimproved areas? Furthermore, how they perceive the improvement project from their perspectives?

The objective and hypothesis of study

This study aims to investigate the differences in farmers' irrigation behavior related to the efficiency and effectiveness of irrigation system between the areas which are covered by the WUAs established under improved irrigation projects and the areas where are still using conventional (unimproved) systems of irrigation. In order to achieve this objective the related hypothesis was formulated to suggest that "there is a difference in efficiency and effectiveness of the irrigation process under the conditions of improved and conventional systems of irrigation".

Methodology

Geographical frame of the study

Behera governorate is chosen as a geographical frame for conducting the study, as agriculture is the main economic activity there. In 2010 the governorate cropping area was 1.158891 million feddans and the quantity of irrigation water used for the three agricultural seasons and fruits were

4587459 m^3. On the other hand, in 2011 the governorate estimated labor force in agriculture, hunting, forestry, and cutting of wood trees with around 1206300, where 671100 of them were Males and 535200 were Females. (CAPMAS, 2012, pp. 85, 128, 130). According to the HDR (2005, p. 15) Rosetta branch of the Nile River provides the governorate with a stable water resource for agriculture. Furthermore, it has moderate weather and an annual rainfall up to 99cm/m^2. That's why Behera got the priority for improving its irrigation system as it is considered the largest agricultural governorate with the highest irrigation water consumption rate, and the largest workforce in agriculture among all the governorates of Egypt.

According to the Human Development Report of 2010 the total HDI of Behera reached 0.733 in 2007/2008 against 0.731 at the national level in the same year. Behera is ranked fifteenth among all the twenty eight governorates (including Luxor) of Egypt.

Behera governorate is one of the leading governorates in the Irrigation Improvement Projects (IIPs) since the early nineties of the last century. IIPs have been implemented for enhancing the efficiency of irrigation water management, and rationalizing farmers' irrigation behavior.

The Irrigation Improvement Project 1 (IIP1) has been followed by Irrigation Improvement Project 2 (IIP2), and Integrated Irrigation Improvement and Management Project (IIIMP). All of them have been implemented on El-Mahmoudia main canal, while one branch canal of it has been left unimproved. Each stage of the project was applied on a number of branch canals located on both sides of El-Mahmoudia main canal. Since it was difficult for the study to cover all branch canals of the main canal, one branch canal was selected from each project domain area to represent the current situation of the improvement irrigation system, namely: El-Herfa, El-Sarania, and Swaki El-Hadid. The unimproved branch canal that was selected to represent the current situation of conventional irrigation system was El-Akab canal.

Sampling

To draw the sample of the study, three *mesqas* were randomly selected on each of the four selected branch canals taking into account their different locations on the canal (Up-stream/Mid-stream/Down-stream) to represent the current situation and the real circumstances surrounding the WUs in this area. One quarter of the total number of farmers on each *mesqa* was randomly selected taking into account their different locations on the *mesqa* (Up-stream/Mid-stream/Down-stream) by assistance of key informants in each mesqa. Thus, we had nine *mesqas* in the improved areas and three *mesqas* on the conventional branch canal to ensure representing the current real situation of WUs on each *mesqa*. The total number of sample reached 186 from both the improved areas (125) and the unimproved area (61).

Variables of the study

The variables of study include a group of independent variables related to the socio-economic characteristics of the actors and dependent variables related to the effectiveness of the farmers' irrigation behavior under both improved and unimproved irrigation systems was measured using several questions each of which measures a specific aspect of irrigation behavior as

a dependent variable. These aspects cover: conflicts among WUs on irrigation water, period used for irrigation process, application of land leveling by laser, cost paid for irrigation, conflict resolution on irrigation water and sufficiency of irrigation water.

The six variables were measured using forms of questions either of nominal scale (dichotomy) pattern as in the case of land leveling or ordinal scale as in the case of other variables.

Data collection tools

Data were collected through individual personal interviews with each of the selected WUs on September, October, and November 2012 by using 2 questionnaires (one for improved *mesqas* and one for unimproved *mesqas*). Both questionnaires were designed, pre-tested, and pre-coded to achieve the objective of the study. During data entry same questions in both questionnaires were merged.

Statistical tools

To achieve the study objective, data processing and analysis were performed using SPSS software, which was used for calculating percentages, frequency, and chi-square for testing the significance of differences.

RESULTS AND DISCUSSION

Conflicts on irrigation water among WUs

In the case of improved areas 46.4% of WUs mentioned that the conflicts have been "increased" against more than one third of WUs (34.4%) in unimproved areas mentioned that conflicts have been "increased". Surprisingly, the percentage of those who mentioned that conflicts "decreased" was 32.80% against 31.10% in the improved and unimproved areas respectively (Fig. 1). Testing the significance of difference of the distribution of respondents in the three categories (increased, no change, and decreased) using Chi^2 showed that differences are insignificant at 0.05 levels.

WUs' conflict resolution on irrigation water

More than three quarters of the WUs (76.2%) in improved areas mentioned that the conflicts on irrigation water were "always" solved against 29.3% in unimproved areas. On the other hand, 46.6% and 24.1% of the sample in the unimproved areas mentioned that these conflicts are solved "sometimes" and "never" respectively compared with 15.6 % and 8.2% in the improved areas respectively (Fig. 2). Testing the significance of difference of the distribution of respondents in the three categories (always, sometime, and never) using Chi^2 showed that differences are significant at 0.000 levels.

Applying land leveling by laser

Three quarters of WUs (75.2%) in improved areas mentioned that they used laser for land leveling. However, nearly the majority of WUs in unimproved areas (88.5%) mentioned that they used laser application for land leveling (Fig. 3). Testing the significance of difference of the distribution of respondents in the two categories (yes, and no) using Chi^2 showed that differences are insignificant at 0.05 levels.

Period used for irrigation

More than half of WUs (52%) in improved areas mentioned that the period used for irrigation became "less than before". In contrast, 41% of WUs in unimproved areas mentioned that the period used for irrigation became "longer than before" (Fig. 4). Testing the significance of difference of the distribution of respondents in the three categories (increased than before, no change, and less than before) using Chi^2 showed that differences are significant at 0.002 levels.

Cost paid for irrigation

About half of the WUs (49.6%) in improved areas mentioned that the cost paid for irrigation has "increased than before" against nearly the majority of WUs (88.5%) in unimproved areas. Nevertheless, the percentage of WUs who mentioned that cost paid for irrigation "decreased than before" was 39.2% against 1.6% in the improved and unimproved areas respectively (Fig. 5). Testing the significance of difference of the distribution of respondents in the three categories (increased than before, no change, and less than before) using Chi^2 showed that differences are significant at 0.000 levels.

Effectiveness of the irrigation process under improved and unimproved irrigation system

This variable was measured through the perceived perception and farmers' assessment of the sufficiency of irrigation water for their crops.

Sufficiency of irrigation water among WUs in both improved and unimproved areas

More than half of WUs (60.8%) in improved areas agreed that irrigation water was "always" sufficient against 11.5% in unimproved areas. Nevertheless, 21.6% and 17.6% of the sample in the improved areas mentioned that irrigation water was "sometimes" and "never" been sufficient respectively compared with 62.3% and 26.2% in the unimproved areas respectively (Fig. 6). Testing the significance of difference of the distribution of respondents in the three categories (always, sometime, and never) using Chi^2 showed that differences are significant at 0.000 levels.

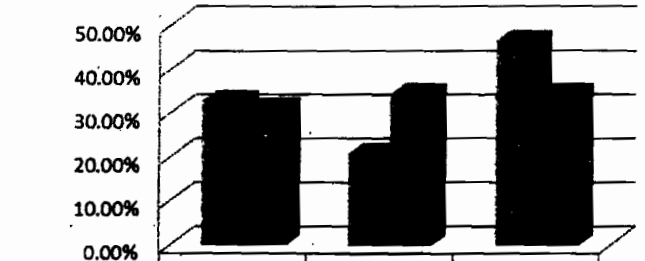
Sufficiency of irrigation water in improved areas in relation with the WUs land location on the *mesqas*

Comparatively, the percentages of WUs who mentioned that irrigation water was "always" sufficient were 78.4%, 50%, and 57.9% on the Up-stream, Mid-stream, and Down-stream of the *mesqa* respectively (Fig. 6.1). Testing the significance of difference of the distribution of respondents in the three categories (always, sometimes, and never) using Chi^2 showed that differences are insignificant at 0.05 levels.

Sufficiency of irrigation water in unimproved areas in relation with the WUs land location on the *mesqas*

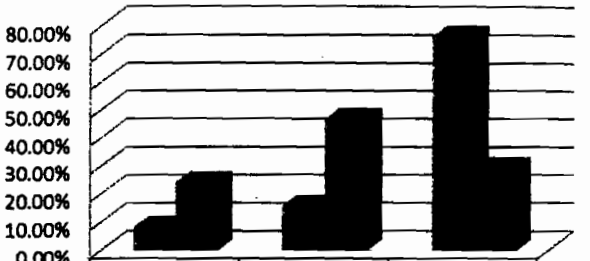
Comparatively, the percentages of WUs who mentioned that irrigation water was "always" sufficient were 5.9%, 21.1%, and 8% on the Up-stream, Mid-stream, and Down-stream of the *mesqa* respectively (Fig. 6.2). Testing the significance of difference of the distribution of respondents in the three categories (always, sometimes, and never) using Chi^2 showed that differences are insignificant at 0.05 levels.

Charts



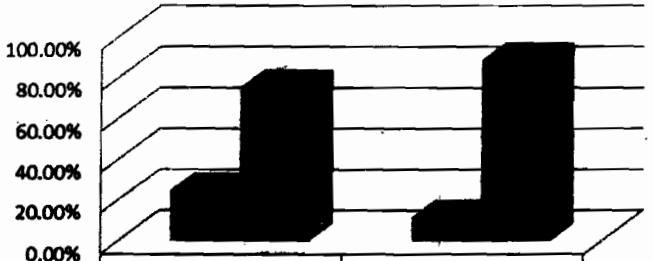
	Decreased	The same	Increased
Improved	32.80%	20.80%	46.40%
Un- improved	31.10%	34.40%	34.40%

Figure. 1 Conflicts among WUs on irrigation water. Not significant at 0.05



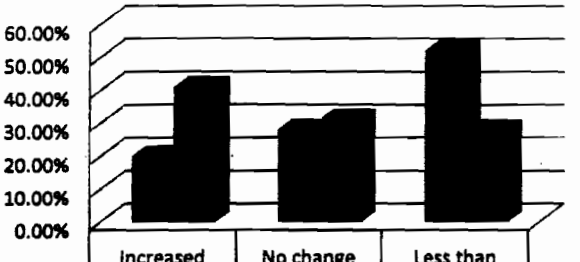
	Never	Sometimes	Always
Improved	8.20%	15.60%	76.20%
Un- improved	24.10%	46.60%	29.30%

Figure. 2 Conflicts resolution on irrigation water. *Significant difference at 0.000



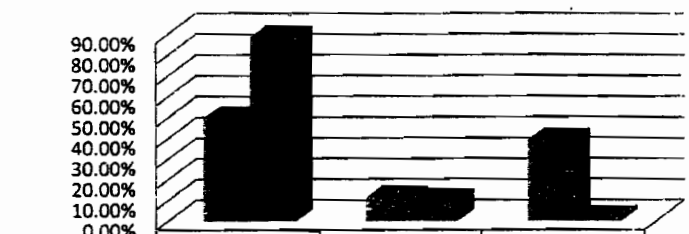
	Improved	Un- improved
No	24.80%	11.50%
Yes	75.20%	88.50%

Figure.3 Application of land leveling by Laser. Not significant at 0.05



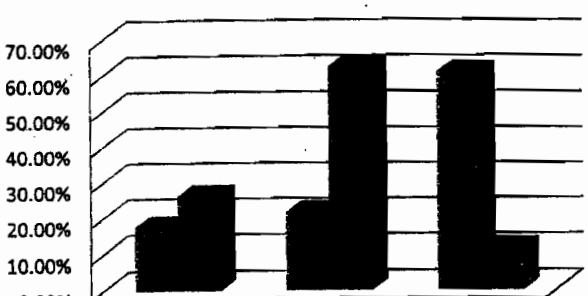
	Increased than before	No change	Less than before
Improved	20.00%	28.00%	52.00%
Un- improved	41.00%	31.10%	27.90%

Figure.4 Period used for irrigation. *Significant difference at 0.002



	Increased than before	No change	Less than before
Improved	49.60%	11.20%	39.20%
Un- improved	88.50%	9.80%	1.60%

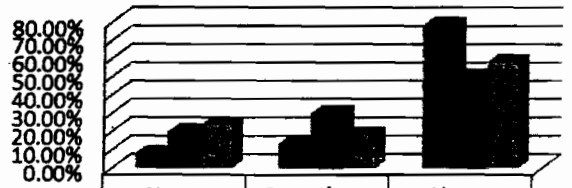
Figure.5 Cost paid for irrigation. *Significant difference at 0.000



	Never	Sometimes	Always
Improved	17.60%	21.60%	60.80%
Un- improved	26.20%	62.30%	11.50%

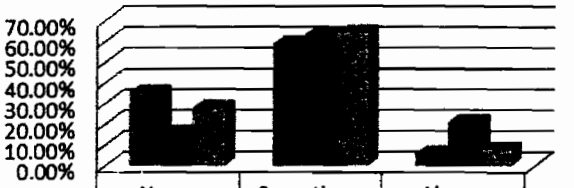
Figure. 6 Sufficiency of irrigation water. *Significant difference at 0.000

Charts of sufficiency of irrigation water according to WUs land location on *mesqa* in improved & unimproved areas



	Never	Sometimes	Always
Up-stream of the Mesqas	8.10%	13.50%	78.40%
Mid-stream of the Mesqas	20.00%	30.00%	50.00%
Down-stream of the Mesqas	23.70%	18.40%	57.90%

Figure. 6.1 Sufficiency of irrigation water in improved areas in contrast with WUs land location on *Mesqas*. Not significant at 0.05



	Never	Sometimes	Always
Up-stream of the Mesqas	35.30%	58.80%	5.90%
Mid-stream of the Mesqas	15.80%	63.20%	21.10%
Down-stream of the Mesqas	28.00%	64.00%	8.00%

Figure. 6.2 Sufficiency of irrigation water in unimproved areas in contrast with WUs land location on *Mesqas*. Not significant at 0.05

This mostly means that improvement of the *mesqa* has positive impact on the equity of water distribution among all farmers regardless of their location on the *mesqa*, especially when compared with the situation in the unimproved areas.

However, during the field data collection some WUs in both improved and unimproved areas reported that irrigation water was insufficient especially during the summer season as they assume that water is directed to Alexandria governorate where tourism is active during that season.

Surprisingly, in the case of improved areas the percentage of WUs who applied laser land technique is less than those in the unimproved areas in spite of the need of using land leveling by laser as a pre-requisite for applying irrigation improvement project on *mesqas*.

Concerning the irrigation water sufficiency farmers accepted the idea of improvement based on the promise of applying the continuous flow of water in branch canals. Although, this promise hasn't been applied and the rotation is retained in the improved areas, farmers in these areas who reported that irrigation water is sufficient in their areas under improvement are still more than unimproved areas.

Conclusion

Deficiencies in the local management of irrigation water could be attributed to defects in the organization of irrigation process. Such situation would consequently increase the possibility of conflicts among WUs and hence decrease both efficiency and effectiveness of the local irrigation system. Improving organization of the system as one of the two components of IIP is likely to contribute to the resolution of these conflicts and this could mean that WUAs has the mechanism to solve irrigation water problems, though they do not have the ability to avoid the arousal of these problems.

Yet, changes of the conditions surrounding irrigation under traditional situations cannot easily absorbed to avoid interruption of the interrelationships among farmers unless they are reorganized to face these changes. However, improvement of the local irrigation management with its two physical and organizational components, though might not fully solve the problem of scarcity but nevertheless, introduce an effective mechanism to solve potential conflicts result from scarcity. Meanwhile, such improvement would help enhancing equity in distribution of irrigation water among the users on the same water channel which this study proved more possible.

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السلوك الأروائي للمزارعين وأوضاعهم الاجتماعيه والاقتصاديه تحت نظم الـــري المطور وغير المطور بمحافظة البحيرة.

محمد حلمي نوار، عزة تهامي البنداري وأحمد نبيل الشربيني

قسم الإجتماع الريفي والإرشاد الزراعي، كلية الزراعة، جامعة القاهرة، الجيزة، مصر

تهدف هذه الدراسة إلى مقارنة بعض جوانب كفاءة وفعالية عملية الري تحت نظـــامي الـــري المطور وغير المطور. وقد أجريت الدراسة في محافظة البحيرة حيث تم تطبيق مـــشروع الـــري المطورعلي ترعة المحمودية الرئيسية. وتم اختيار ثلاثة ترع فرعية تم تطوير نظم الري بهم مـــن قبل مشروع الري المطور وترعة فرعية أخري لم يتم تغطيها من قبل المشروع لتمثيل الوضـــع الحالي لنظم الري في كل من المنطقتين (المطورة وغير المطورة). تم اختيار ثلاثة مساقي من كل ترعة فرعية مع الأخذ في الاعتبار مواقع تلك المساقي علي بدايات ومنتـــصف ونهايـــات التـــرع الفرعية.

تم اختيارعينة عشوائية من الزراع يمثلون بدايات ومنتصف ونهايات المساقي لتمثيل المساقي المطورة وغير المطورة وبلغ حجم العينة المختارة ١٢٥ مزارعا مـــن المـــساقي المطـــورة و٦١ مزارعا من المساقي غير المطورة مع الأخذ في الاعتبار موقع الزراع علي بـــدايات ومنتـــصف ونهايات المساقي وذلك بإجمالي ١٨٦ مبحوثا. وتم جمع البيانات من خلال المقابلة الشخصية مـــع

المبحوثين باستخدام استبيانين (استبيان للزراع بالمساقي المطورة واستبيان آخر للزراع بالمساقي غير المطورة). وتشير النتائج إلي ما يلي:

أن 46.4٪ و ٣٤.٤٪ من المبحوثين أشاروا إلي أن الصراعات على مياه الري "زادت" في المناطق المطورة وغير المطورة على الترتيب، في حين أن 76.2٪ و ٢٩.٣٪ على التوالي أشاروا أن مثل هذه الصراعات يتم حلها بصفه "دائمه". كما تبين أن 75.2٪ و ٨٨.٥٪ من المبحوثين قاموا "باستخدام" تسوية الأراضي بالليزر على التوالي. وقد وجد أيضا أن الفترة المستخدمة في الري "أقل من ذي قبل" بنسبة ٥٢٪ و ٢٧.٩٪ على التوالي. كما وجد أن تكلفة الري "أقل من ذي قبل" نسبة ٣٩.٢٪ و ١.٦٪ على التوالي. واعتبرت كمية مياه الري "كافية" بنسبة 60.85٪ و ١١.٥٪ على التوالي، بينما تبين وجود علاقات ارتباط معنوية بين نظم الري المطورة وغير المطورة وكل من الفعالية في فض النزاعات، الفترة المستخدمة في الري، تكاليف الري، وكفاية مياه الري.

يستخلص من هذه النتائج، أن تحسين مكونات إدارة الري المحلية في كل من مكونات التقنيات المستخدمة وتنظيم المزارعين في سياق عملية الري قد يساعد في تعزيز توزيع مياه الري بين المنتفعين بإنصاف، وبالتالي يمكن أن يسهم في تحسين كفاءة وفاعلية نظام الري المحلي.

الكلمات الدالة : السلوك الإرواني، نظم الري، البحيرة، مصر.

قام بتحكيم البحث

أ.د / محمد السيد الامام — **كلية الزراعة – جامعة المنصورة**

أ.د / سوزان محى الدين نصرت — **كلية الزراعة – جامعة القاهره**