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Déterminants institutionnels de l'adoption d'innovations dans l'agriculture marocaine: le cas du LIT dans la région de Draa-Tafilalet

Institutional Determinants of the Adoption of Innovations in Moroccan Agriculture: The Case of LIT in the Draa-Tafilalt Region

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Abstract

The purpose of this study was to examine the role and influence of institutional variables in the adoption of localized irrigation technology (LIT) by farmers in the Draa- Tafilalt region. Given the nature of our problem and in order to test the hypotheses built around our conceptual model, we have adopted the hypothetical-deductive approach in this work, which is part of a "positivist" perspective, and the quantitative method by face-to-face survey as a research strategy. The estimation of the parameters of the binary logit model using SPSS version 25 software, carried out on the basis of data collected by questionnaire from 400 farmers in the Draa-Tafilalt region revealed that among the five institutional variables used in this study, four variables have a significant and positive effect on the probability of adopting the LIT. Three variables with less than 1% probability level ("access to credit", "access to subsidy" and "social influence") and one variable with less than 5% probability level ("contact with extension agents"). Unexpectedly, the result of the binary logistic regression also revealed that the role of the explanatory variable "membership in a cooperative or association" in the adoption of LIT in the study area is not significant.

Keywords: Adoption, institutional variables, LIT, logit, Draa-Tafilalt region.

1. Introduction

Today, the driving role of innovation in the development of economies is therefore no longer in doubt. One of the most striking phenomena is the irruption of innovations and technologies in all sectors of activity. Agriculture has not escaped this movement.

Although the importance of agricultural innovations is well understood in the economic literature, the factors that influence the adoption of innovations are less obvious. An innovation may be accepted within a year, but the acceptance of another innovation may take several decades. Not all farmers will accept an innovation at the same time, but some will accept the innovation sooner or later (Rogers & Shomiar, 2000).

Since Griliches'(1957) first well-known work in Economics on the dissemination of hybrid corn varieties in the United States, much attention has been devoted to studying the adoption of new agricultural technologies. Today, the adoption of innovations in agriculture has attracted considerable interest from development economists because the majority of people in developing countries make their living from agricultural production. Thus, new technologies seem to offer an opportunity to change the productive efficiency of the farmer in terms of quantity and quality and to increase production and incomes considerably (Feder & al; 1985).

In Morocco, agriculture is one of the most important economic sectors and accounts for a considerable percentage of production and employment. It is also the main user of water, and the scarcity of water resources, which differs from region to region, remains the most hampering problem for the development of Moroccan agriculture. In addition, the use of traditional irrigation methods with a low efficiency of less than 50% have aggravated this situation.

In this regard, one of the most important and effective ways to address the water crisis is to increase irrigation efficiency through the use of water-efficient irrigation technologies. Among existing irrigation technologies, LIT has the highest efficiency rate (with irrigation efficiency of up to 90-95%).

Although switching to LIT has often been proposed as a solution to the problem of water scarcity. In Morocco, adoption of this technology is low and continues at a slow pace. Despite efforts and financial incentives to accelerate the adoption of LIT, the areas currently equipped with LIT represent a negligible share of the potential. In 2018, the total area equipped is estimated at 540000 ha (Ministry of Agriculture and Maritime Fisheries, 2019) compared to a total UAA of nearly 8.7 million hectares, of which nearly 1.36 million hectares are

permanently irrigable (Belghiti, 2005). It is therefore important to identify the reasons why the LIT is not adopted to the extent planned.

Although LIT has been widely adopted in other regions of the country (in the Oulmès region since 1979, in the Souss region since 1976, in the Gharb region since 1980), the adoption of this technology in the Draa-Tafilalt region is very recent. It is therefore a real innovation for the farmers of the region which is now being disseminated. According to Rogers, « a phenomenon is considered an innovation if it is perceived as new where it appears ».

The definition that seems best suited to our study is that of D.M. Rogers (2003) & Adams (1982), according to which innovation is anything that is perceived by the farmer as new, regardless of the objective novelty of the idea or product, and that leads to a sustainable increase in productivity and farm income. It is also important to note that for both Rogers and us the terms innovation and technology will be used interchangeably in this study. Therefore, in this study we will refer to "LIT adoption" as the behavior of acceptance and actual use of LIT at the farm level. In the literature reviewed several individual, economic, technological and institutional variables were identified as determinants of LIT adoption. In this study we will limit ourselves to the role of institutional variables in the adoption of LIT. This study is thus deficient in addressing the following question: **To what extent do institutional variables influence LIT adoption in the Draa-Tafilalt region?**

The remainder of this paper is organized into four sections. The second section is devoted to the presentation of the institutional variables selected in this study and the related hypotheses. The third section deals with the methodology for data collection and the strategy for data analysis. The fourth section deals with the results and their discussion. Finally, the fifth section is devoted to the conclusion and perspectives.

2. Literature review: Variables and related hypotheses

Drawing on the UTAUT[1] Venkatesh & al. (2003) from which the variable "Social influence" was derived, the literature review conducted as part of this research and the context of the study area, and in order to construct our conceptual research model (Figure No. 1) we selected five institutional factors: Social influence, Access to credit, Access to subsidy, Contact with extension agents, Membership in a cooperative or association. The hypotheses related to these factors are developed in the rest of this section.

Figure 1: The conceptual model for institutional factors
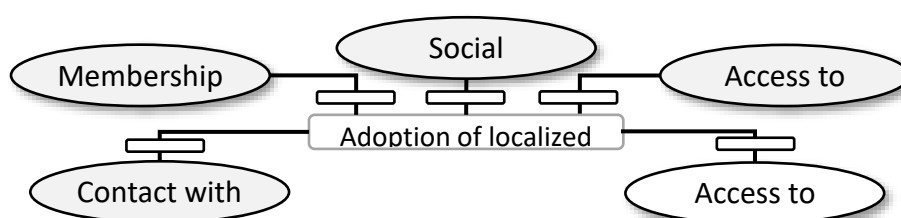
Source: Authors

2.1 Social influence

Social influence, reflects the effect of environmental factors such as the opinions of a user's friends, of parents, and superiors on user behavior. It is similar to the subjective norm of Ajzen's (1985) theory of planned behavioural technology adoption which explains the individual's perception that most people who are important to him or her believe that he or she should or should not perform the behaviour in question (Fishbein & Ajzen ,1975). The study by Nima & al (2018) on factors affecting the adoption of pressure irrigation technology among Roudbar olive farmers in Iran showed a significant relationship between social influence and behavioural intention.

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[1] Unified Theory of Acceptance and Use of Technology

In this study and even if some works do not find significant relationship between social influence and adoption (for example the study of Amin & al. (2013), we consider that social influence positively influences LIT adoption. Therefore, we will test the following hypothesis:

> **H1** *The perception of "social influence" positively influences the probability of LIT adoption by farmers*

2.2 Access to credit

Empirical studies have shown that access to credit by farmers facilitates their adoption of agricultural technologies (Mohamed & Temu, 2008; He & al., 2007; Mwangi & Kariuki, 2015; Alcon & al., 2011). In these studies, access to credit is often cited as an important factor in the adoption of agricultural technologies. In particular, technologies that require a large initial investment such as irrigation technologies. In Morocco, farmers' limited ability to obtain credit and the lack of credit availability tailored to the needs of farmers wishing to adopt agricultural technologies may hinder adoption. To this end, we will make the following hypothesis:

> **H2** *Perception of ease of access to credit positively influences the probability of adoption of LIT by farmers*

2.3 Access to the subsidy

Generally, investment subsidies reduce the cost of technology and provide strong incentives for farmers to adopt irrigation technologies (B.Zhang et al.2018). More importantly, when access to subsidies is less restrictive for farmers, they are more likely to adopt irrigation technologies. Several authors have shown that the conditions of access to the subsidy and its amount strongly modify farmers' behavior (Richefort ,2010; Belaidi ,2012; Dinar & Yaron, 1992; Bekkar & al., 2007; Salhi & Bedrani, 2007; Salhi & Bedrani, 2010; Benouniche & al., 2011). In this study we consider that the amount and ease of access to the subsidy influence the adoption of LIT. Based on this finding, we will formulate the following hypothesis:

> **H3** *Access to the equipment subsidy positively influences the probability of adoption of LIT by farmers*

2.4 Contact with extension agents

The extension service is responsible for simplifying research information and communicating it to farmers in an efficient and easy-to-understand manner. Extension services such as on-farm demonstrations or training sessions on irrigation technologies play a very important role in disseminating information on these technologies. Dinar & Voet (1992) and Bonabana-

Wabbi (2002) revealed that extension services can offset the negative effect of education on the adoption of certain technologies.

Many authors have also reported a positive relationship between extension services and technology adoption. An example is Mariano et al (2012) for whom contact with extension agents encourages farmers to adopt technologies. Similarly, for Belaidi (2012) who showed that in Algeria extension services positively influence the adoption of water saving technologies. In this study we consider that information plays a fundamental role in the adoption process and that farmers' contact with extension agents stimulates LIT adoption. Therefore we will test the following hypothesis:

| **H4** | *Contact with extension agents positively influences the adoption of LIT* |

2.5 Membership in a cooperative or association

Membership in a cooperative or association helps farmers to obtain information on new technologies, which tends to promote the adoption of new agricultural technologies (Bandiera & Rasul, 2006; Abdulai et al., 2011). In this sense, Abdulai et al. (2011) and Mariano et al. (2012) suggested that being a member of a farmers' cooperative increases the probability of adopting new agricultural technologies.

Also, Abdulai & al (2011) showed that in Ghana, farmers who participate in such organizations are more likely to adopt localized irrigation technologies.

In this study, we agree with the idea of Uaiene & al. (2009) that individual farmers' decisions on the adoption of agricultural technologies are influenced by whether or not they belong to an agricultural cooperative or association. Therefore, we will test the following hypothesis:

| **H5** | *Membership in a cooperative or association positively influences the probability of adoption of LIT* |

3. Methodology and data

3.1 Survey: Design, administration and validity

Given the nature of our problem and in order to be able to test the hypotheses built around our conceptual model, we have adopted the hypothetical-deductive approach in this work, which is in line with a "positivist" perspective, and the quantitative method by means of a face-to-face survey as our research strategy. The development of the survey and the choice of measures for each variable was based on the research hypotheses underlying our conceptual model and the literature review.

The dependent variable in our conceptual model is whether or not farmers adopt the localized irrigation technology. This is a dichotomous or binary choice variable. In our case the dependent variable or variable to be explained is coded as follows: 1 if the farmer adopts the localized irrigation technology; 0 if he does not adopt it.

In this study the explanatory variables that determine the adoption of the localized irrigation technology are: Social influence, access to credit, access to subsidy, contact with extension agents, membership in a cooperative or association. To measure the independent variables, social influence, access to credit, access to subsidy, we chose to use the subjective or perceived method. The following table presents the variables of the model as well as the way they are operationalized.

Table 1: the variables of the model as well as the way they are operationalized

Variables	Coding	Measure
Adoption	Adop	1 if the farmer adopts the localized irrigation technology; 0 if he does not adopt it
Explanatory variables		
Social influence	Inf_so 1	People who influence my behavior (colleagues, friends, family) think I should use LIT
	Inf_so 2	People who are important to me think I should use LIT
	Inf_so 3	People whose opinions I value prefer that I use LIT
	Inf_so 4	The Ministry of Agriculture as a whole promotes the use of LIT
	Inf_so 5	My neighbor encourages me to use LIT
Access to credit	Acc_crédit 1	Having easy access to credit to equip the LIT is (will be) encouraging to me
	Acc_crédit 2	I use (will use) LIT because I have (will have) access to credit
	Acc_crédit 3	I find that I have all the necessary conditions to have access to credit to equip myself with the LIT
	Acc_crédit 4	Access to credit for LIT equipment is easy for me
Access to subsidy	Acc_sub 1	I use (will use) the LIT because it is subsidized by the state
	Acc_sub 2	I use (will use) LIT because I have (will have) access to the state grant
	Acc_sub 3	I find that access to the grant makes it easier for me to adopt LIT
	Acc_sub 4	I find that I have all the necessary requirements to access the grant
Contact with extension agents	Con_age_vulg	1 if in the last two years the farmer has been in contact with extension agents; 0 otherwise
Membership in a cooperative or association	App_coo_ass	1 if the farmer is a member of a cooperative or association of farmers; 0 otherwise

Source: Authors

It is important to note that the choice of a face-to-face interview with our survey was not made by chance. This method is considered to be the most effective in terms of the quantity and quality of the information collected. Also, the specificity of our research object which generally concerns the perceptions and attitudes of farmers regarding the use of localized irrigation technology, on the one hand, and the specificities of the population studied (farmers) which is generally uneducated, on the other hand, obliged us to choose this mode of administration which allows us to be close to the farmer interviewed and to rule out the possibility of using other modes of administration of the survey which require an average level of education.

In the framework of this research work, once the questionnaire was established, the validity of the survey and its content was verified in two stages:

The first step is the validity of its content which was determined by consulting two professors from the Hassan II Agronomic and Veterinary Institute, a professor at the FLESSM[2] and an expert irrigation engineer at the ROADO[3] who evaluated the relevance and objectivity of each element of the survey and the duration of the questionnaire: a response time between 20 and 30 minutes was set.

The pre-test with farmers is the second step in this process of validity of the survey. Thus, once the survey is redesigned, we found it useful to pre-test it. For this study, 20 farmers from the province of Midelt[4], were interviewed during this pre-test, which was called a pilot study. First, permission was sought from local authorities to conduct interviews with 20 farmers. After receiving permission, 20 farmers were then randomly selected according to their availability, 5 of whom were adopters of the localized irrigation technology. This was important in the research process because it helped us identify vague questions and unclear instructions. It also helped us to capture important comments and suggestions from farmers, to discover appropriate vocabulary, commonly used terms, and to identify the meaning given to words. This helped us to improve the efficiency of our survey. It should be noted that at the time of the interviews we found that conducting interviews with farmers in the local language using a French-language survey was very difficult to manage and could even be a source of dissatisfaction for the farmer. Therefore, we decided to use a survey in Arabic, the language mainly used by farmers in the study area.

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[2] Faculty of Legal, Economic and Social Sciences of Marrakech
[3] regional office of agricultural development of Ouarzazate
[4] This is because it is a province that is part of the main study area and the closest to us

After presenting and explaining how the content of our survey was constructed, as well as the validation and the mode of administration retained for the collection of data. In the rest of this section, we will present the sample size and the sampling technique.

3.2 Sample size and sampling technique

The study targeted farms in the Drâa-Tafilalet region. For a total population of approximately 95,643 farms in the Drâa-Tafilalet region, and based on Cochran's formula, a minimum sample size of 383 is calculated for a 95% confidence level (z = 1.96) and a precision margin of error of 5%. For the estimated proportion (p) of the population with the characteristic studied in this research, i.e. the adoption or not of the LIT, and in the absence of absolute knowledge on the proportion of adopting farmers, we used p = 0.5, which corresponds to the worst case, i.e. the largest dispersion, and which maximizes the minimum sample size.

For the selection of 400 farmers from the Draa-Tafilalet region, and given the absence of a complete list of farms in the Draa Tafilalt region from which to draw a random sample, and in order to obtain a fair representation of farmers from each of the provinces, the sampling technique proportional to the size of the population of the province was used (Table 2). Then, farmers in each of the five provinces were randomly selected based on their availability and willingness to participate in the interviews.

Table 2: The number of farmers surveyed by province according to the sampling technique proportional to the population size of the province

Provinces	Number of Farms (Population)	Percentage (%)	Number of Farms (Sample)
Errachidia	18 588	19,43	78
Ouarzazate	17 978	18,80	75
Midelt	17 968	18,79	75
Zagora	20051	20,96	84
Tinghir	21058	22,02	88
Region :Drâa - Tafilalet	**95 643**	**100**	**400**

Source: Author's calculation based on data from the 2016 General Census of

Agriculture

3.3 Data analysis strategy and model

In order to be able to test the hypotheses built around our conceptual model, the processing of the data collected in this study necessarily goes through two stages. The first exploratory step consists of using exploratory factor analysis to determine the measurement scales. Thus, first, a correlation analysis between the items of each of the three variables measured by several items is performed. Then, the test of the reliability of the items (Cronbach's Alpha) and the principal component factor analysis with the orthogonal rotation of Varimax type were carried out.

The second step is confirmatory. In this stage we performed the confirmatory analysis that allowed us to analyze the relationships between the variables of the model studied. To this end, we used the binary logistic regression model to test the research hypotheses and identify the variables that most influence the adoption of localized irrigation technology in the study area. This model is written as follows:

$$\text{Log } (P_i/1-P_i) = \beta_0 + \beta_i \text{ institutional determinants} + \varepsilon$$

Where

β_i (i = 1,2,3,4,5) are the coefficients attached to the institutional determinants of adoption of the localized irrigation technology namely Social influence, Access to credit, Access to subsidy, Contact with extension agents, Membership in a cooperative or association. ε is the error term.

4. Results and discussions

4.1 Sample Characteristics

The data used in this study were collected from 400 farmers in the Draa- Tafilalet region, including 148 (37%) LIT adopters and 252 (63%) non-adopters. The age of the farmers in our sample ranged from 32 to 72 years with an average age of 53 years. The experience of the farmers studied ranged from 1 to 52 years with an average of 14 years. With regard to education level, the statistical analysis presented in the following graph reveals that the majority of farmers in our sample (70%) have a primary level (30%) or never attended school (40%). This shows the low education level of the farmers surveyed. On the other hand, farmers with secondary or higher education levels represent less than 30% of the sample.

Graph 1: Distribution of the farmers studied according to their education level
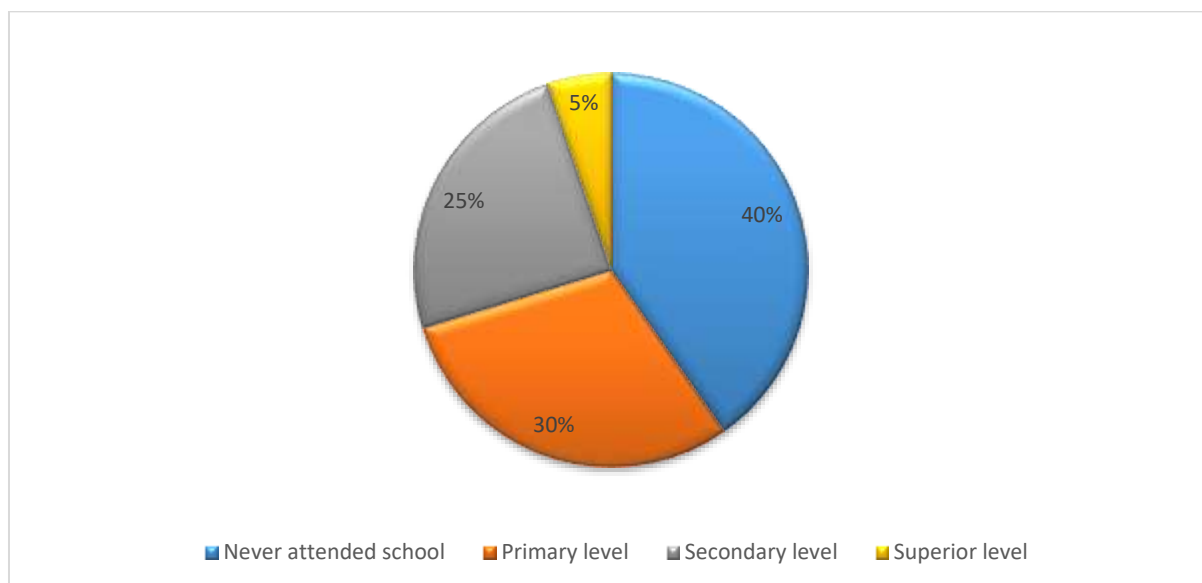
Source: Results of our study

In this study, farmers' contact with extension agents is a dichotomous variable that takes on a value of 1 if the farmer has been in contact with extension agents in the last two years and 0 if the farmer has not been in contact with extension agents. From the table below we see that among the 400 farms in our sample, more than half (52.3%) of the farmers reported that they had not been in contact with extension agents in the last two years. This includes 209 farms of which 161 farms (over 70%) are non-adopters of LIT. Despite the importance of farmers having had contact with extension agents (191 farms) and considering the important role that LIT extension plays in its adoption, in our studies we found a deficiency in the quality of information provided, frequency of visits and especially the type of farms targeted. In general, extension agents generally target large farms. The majority of farmers in our sample report that they are not fully conversant with LIT, especially when it comes to data on the duration and frequency of irrigation and the amount of fertilizer to be used by crop type.

Table 3: Distribution of surveyed farmers according to their contact with extension agents and by group (LIT and non-LIT adopters)

Contact with the extension agents	Non-Adopting LIT		Adopting LIT		Total	
	Number	%	Number	%	Number	%
In the last two years the farmer has not been in contact with the extension agents	161	63,9	48	32,4	209	52,3
In the last two years the farmer has been in contact with the extension agents	91	36,1	100	67,6	191	47,8

Source: Results of our study,2020

Comparative analysis between LIT adopters and non-adopters according to contact with extension agents (table 3) showed that more than 67% of LIT adopter's farmers had been in contact with extension agents in the last two years. In contrast, over 63% of non-adopters of LIT had not been in contact with extension agents in the last two years. Thus, we find that contact with extension agents facilitates the adoption of LIT and the absence of such contact discourages adoption.

Membership in a cooperative or association is a dichotomous variable that takes the value 1 if the farmer is a member of a farmers' cooperative or association and 0 if he is not. The table below shows that in our sample, 181 (45.3% of the sample) farmers reported that they are members of a farmers' cooperative or association and more than half 54.8% (219 farmers) reported that they are not.

Table 4: Distribution of surveyed farmers according to their membership in a cooperative or association and by group (LIT and non-LIT adopters)

Membership in a cooperative or association	Non-Adopting LIT		Adopting LIT		Total	
	Number	**%**	**Number**	**%**	**Number**	**%**
The farmer is not a member of a farmers' cooperative or association	154	61,1	65	43,9	219	54,8
The farmer is a member of a farmers' cooperative or association	98	38,9	83	56,1	181	45,3

Source: Results of our study,2020

This table also reveals that more than 56% of LIT adopters are members of a farmers' cooperative or association and less than 44% or 65 farmers are not. On the other hand, over 61% of non-adopters of the LIT are not members of a farmers' cooperative or association and only 98 farmers are members of a farmers' cooperative or association. We therefore find that membership in a cooperative or association facilitates the adoption of LIT.

4.2 PCA and item reliability results

Of the five institutional variables that explain the adoption of LIT in this study, three are measured by multiple items. These are "Social influence," "Access to credit," and "Access to subsidy. In order to use these variables as explanatory variables, it is imperative to verify their unidimensionality and internal consistency. Thus, first of all, a correlation analysis between the items of each of the three variables is carried out. Then, the test of the reliability of the

items (Cronbach's Alpha) and the principal component factorial analysis with orthogonal rotation of Varimax type were performed. The results of these analyses are shown in the table below.

Table 5: Summary of PCA Results and Item Reliability

Variable	Item Code	Communality	Variance explained	Cronbach's Alpha of the scale
Social influence	Inf_so 1	0,673	64,217	0,807
	Inf_so 2	0,708		
	Inf_so 3	0,672		
	Inf_so 4	0,516		
	Inf_so 5	The quality of representation of this item does not meet the recommended threshold (0.4)	Decision: Withdrawal of this item	
Access to credit	Acc_crédit 2	The factor contribution of this Item is below the required threshold of 0.5	Decision: Withdrawal of this item	
	Acc_crédit 1	0,659	74,891	0,820
	Acc_crédit 3	0,864		
	Acc_crédit 4	0,724		
Access to subsidy	Acc_sub 1	0,613	69,757	0,764
	Acc_sub 2	0,708		
	Acc_sub 3	0,771		
	Acc_sub 4	The factor contribution of this item is well below the required threshold of 0.5	Decision: Withdrawal of this item	

Author's calculation using SPSS

These results show that, overall, the scales are generally satisfactory and have a good level of reliability. However, three items were eliminated following the exploratory factor analysis, namely:

- The Inf_so 5 item which presented a quality of representation that does not meet the required threshold of (0.4)

- Item Acc_credit 2 and Acc_sub 4, which showed a factor contribution well below the required threshold of 0.5.

4.3 Binary logistic regression and hypothesis testing

Verification of the assumptions underlying the use of the logit model to estimate the parameters of the explanatory model of the institutional variables of LIT adoption by farmers in the Draa-Tafilalt region yielded the results shown in the following two tables.

Table 6: Tolerance and VIF Test Results

Variables		Colinearity statistics	
		Tolerance	**VIF**
1	(Constant)		
	Contact with extension agents	0,897	1,115
	Membership in a cooperative or association	0,865	1,156
	Social influence	0,882	1,133
	Access to credit	**0,732**	**1,365**
	Access to subsidy	0,876	1,142

Author's calculation using SPSS

Table 7: Test of bivariate correlation between predicted values and standardized residuals

		Predicted values	Standardized Residue
Predicted values	**Pearson Correlation**	1	-0,008
	Sig. (bilateral)		0,876
	N	400	400

Author's calculation using SPSS

Table 6 presents the results of the tolerance and VIF[5] tests. These results indicate that the lowest observed value for tolerance is 0.732 and the highest value for VIF is 1.365, indicating that there are no multicolinearity problems in the regression model used in the sense of Garson (1998) which recommends a VIF strictly lower than 4 and a tolerance higher than 0.25.

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[5] Variance Inflation Factor

Table 7 presents the result of the error independence test. To carry out this test, we carried out the bivariate correlation test between the predicted values and the standardized residuals. The result of this test reveals that the correlation between the two variables is insignificant and tends towards 0 (-.008). Thus, the assumption of error independence is verified.

After having verified the two hypotheses underlying the use of the logit model, we will now proceed to the interpretation of the results from the estimation of this explanatory model of the institutional determinants of LIT adoption by farmers in the Draa-Tafilalt region.

By regressing the five (5) institutional determinants on the dependent variable "LIT adoption", we obtained the results grouped in the table below.

Table 8 : Binary logistic regression results

Variables	B	E.S	Wald	ddl	Sig.	Exp(B)
Contact with extension agents	,599	,304	3,889	1	,049	1,820
Membership in a cooperative or association	,296	,306	,938	1	,333	1,345
Social influence	,568	,173	10,833	1	,001	1,765
Access to credit	1,747	,301	33,767	1	,000	5,737
Access to subsidy	1,635	,247	43,787	1	,000	5,132
Constant	-14,549	1,434	102,886	1	,000	,000
Log likelihood -2						300,720
R^2 of Cox and Snell						0,432
R^2 of Nagelkerke						0,590
Overall percentage of classification without variables						63
Overall percentage of classification after entry of institutional variables						85.8

Author's calculation using SPSS

From the above table we find that institutional determinants explain 59% of the total variance in LIT adoption by farmers in the Draa-Tafilalt region. This result is supported by the improvement in the overall percentage of classification which increased from 63% to 85.8%. Thus, institutional variables alone are sufficient to correctly classify 85.8% of farms between LIT adopters and non-adopters.

The results of the binary logit regression to estimate the explanatory model of the institutional variables for LIT adoption in the Draa-Tafilalt Region (Table 8) revealed that four variables had a significant and positive effect on the probability of LIT adoption, three of which had less than 1% of the probability of adoption ("access to credit", "access to subsidy" and "social

influence") and one variable with less than 5% of the probability of adoption ("contact with extension agents"). Unexpectedly, the logistic regression result also revealed that the role of the explanatory variable "membership in a cooperative or association" in the adoption of LIT in the study area is not significant.

Therefore, hypotheses H1, H2, H3and H4 are confirmed. On the other hand, hypothesis H5 is rejected. Based on the results shown in Table 8, the institutional determinants model that will predict the adoption of LIT in the Draa-Tafilalt region is written as follows:

Log (P/1-P) = 0,568*« Social influence » + 1,747*« Access to credit » + 1.635*« Access to subsidy » + 0,599*« Contact with extension agents » + 0,296*« Membership in a cooperative or association » -14.549

4.4 Discussion: The Role of Institutional Determinants in the Adoption of LIT

The results of this study showed that institutional variables such as "access to credit," "access to subsidy," "social influence," and "contact with extension agents" are significant and have positive effects on LIT adoption. Access to credit is important in constructing the decision to adopt or not adopt LIT. In this sense, Mariano et al (2012); Mwangi & Kariuki (2015) indicated that the availability of credit encourages the adoption of agricultural technologies. In our case, the results showed that the farmer's access to credit is a significant predictor that positively influences at the 1% significance level the adoption of LIT in the Draa-Tafilalt region (B= 1.747). The same result is obtained in China by He et al, (2007) who found a positive and significant relationship between credit availability and adoption of localized irrigation technologies. Thus, the ease of access to credit by farmers is considered an important factor promoting the adoption of agricultural innovations, especially technologies that require a large initial investment such as LIT. This result reinforces the idea that the difficulty of access to credit limits the adoption of LIT.

In the same vein, and in relation to our context, we can only confirm this by the fact that the low capacity of farmers in the region to contract credit and the lack of credit offers adapted to the needs of farmers wishing to adopt LIT may amplify this finding. The findings of this research are consistent with those of Mohamed & Temu (2008); G. Federet & al (1985); Lowdermilk (1972); He & al (2007); Mwangi & Kariuki (2015); Alcon & al (2011); Lipton (1976) and Bhalla (1979) which revealed that access to credit stimulates the adoption of agricultural technologies such as LIT. On our part, and based on the results of this research, we

consider that farmers' access to credit enables them, among other things, to diversify sources of financing for LIT investment and to overcome budgetary constraints that may hinder the adoption of this water-saving technology. This role of access to credit in the adoption of LIT through diversification of funding sources can be complemented by the lead role that can be played by the investment subsidies provided to farmers under the NIWSP[6].

In Morocco, subsidies have increased over the years. Initially, the subsidy rate for micro-irrigation was around 17 percent (1990); this rate rose to 30-40% in 2002, then to 60 percent in 2006 and currently to 80 percent for farms larger than 5 ha, and to 100 percent (with a ceiling) for farms smaller than 5 ha (Molle and Tanouti, 2017). Investment subsidies reduce the cost of technology and provide strong incentives for farmers to adopt irrigation technologies (B.Zhang & al., 018). More importantly, when access to subsidies is less restrictive for farmers, they are more likely to adopt irrigation technologies. Several studies have shown that the conditions of access to the subsidy and the amount of the subsidy strongly modify farmers' behavior. In this sense, the study by Bekkar & al. (2007) on farmers' motivations for adopting localized irrigation in the Tadla perimeter showed that access to the subsidy for conversion to localized irrigation is also an important element in reducing financial risks. In this study, binary logit regression results for the estimation of the explanatory model of the institutional variables for LIT adoption in the Draa-Tafilalt region revealed that the variable "access to subsidy" has a positive and significant effect on the probability of LIT adoption at the 1% significance level (B= 1.635). This result implies that the more farmers have access to the NIWSP subsidy, the greater the probability of adopting the technology. The result of this study confirms the earlier findings of Belaidi et al (2012); B. zhang & al (2019); Dinar & Yaron (1992); Bekkar & al (2007); Salhi & Bedrani (2007); Salhi & Bedrani (2010) and Benouniche et al (2011) for whom the conditions of access to the subsidy and its amount strongly modify farmers' behavior in terms of adopting agricultural technologies and innovations. At this stage we would like to recall that the access of farmers in the region to the subsidy is generally affected by the availability and access to information on the conditions and documents to be provided to benefit from these subsidies. It is in this sense that contacts between extension agents and farmers can make information on subsidies accessible to all farmers.

Agricultural extension services are essential to agricultural development. The extension service is responsible for simplifying information and getting it to farmers in an efficient and easy-to-

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[6] National Irrigation Water Saving Programme

understand manner. Regarding the role of farmers' contact with extension agents in LIT adoption and following the study by Mariano et al (2012) for whom contact with extension agents encourages farmers to adopt technologies, in the Draa-Tafilalt region the variable "contact with extension agents" is also a predictor of LIT adoption. Thus, the results of this research showed that farmers' contact with extension agents is positively correlated with LIT adoption (B=0.599) at the 5% significance level. This result indicates that contact with extension agents is an important element in the process of adoption of agricultural innovations and technologies such as LIT. Contact with the extension agent facilitates access to information and promotes the adoption of LIT. The results obtained are consistent with those of Belaidi (2012) which showed that in Algeria extension services positively influence the adoption of water saving technologies. The same is true in Nepal (Ghimine & Huang, 2015), Cameroon (Mabah & al., 2013), Bangladesh (Miah & al., 2015), Kenya (Timu & al., 2014) and Mali (Adéoti & al., 2002). On this basis we can consider that information plays a fundamental role in the adoption process and that farmer contact with extension agents stimulates LIT adoption by farmers in the study area. Nearly 68% of farmers adopting LIT in the Draa-Tafilalt region have been in contact with extension agents in the last two years.

The variable "Social influence" inspired by UTAUT (Venkatesh et al., 2003) which refers to the social influence of the farmer, that is to say, the set of beliefs about the opinion of individuals or reference groups regarding the adoption of LIT, positively and significantly influences the decisions of farmers in the Draa-Tafilalt Region to adopt LIT at the 1% significance level (B= 0.568). This result confirms the findings of the study by Nima & al (2018) on factors affecting the adoption of pressure irrigation technology among Roudbar olive farmers in Iran and the study by Momvandi, A & al. (2018) which aimed at identifying the factors affecting the use of pressure irrigation technologies by farmers and revealed that subjective norms (social influence) are among the most important factors influencing farmers' behavior towards the use of pressure irrigation technology. On our part, and on the basis of the results obtained, we consider that in our context (crops are collectivist in nature and are focused on the group rather than on the individual), the opinions of the people who influence the farmer's behaviour or those who are important to him (colleagues, friends, family, neighbors, administration) significantly influence his choice of the irrigation technology to be used.

The variable "Membership in a cooperative or association" used in the institutional determinants model to predict the adoption of LIT in the Draa-Tafilalt region did not show

significant significance (P-value =0.333). Indeed, the insignificance of this variable in the adoption of LIT could be explained by the weak role of these associations in framing and improving farmers' social capital and in exchanging ideas and information on new technologies. In addition, during our studies, we learned that the activity of the majority of the associations to which farmers belong is on hold. In the same sense, several farmers stated that the associations were created to benefit only from the subsidies and aids granted within the framework of the NIHD[7], NADOAZ[8] or NGO[9]. To the extent that membership in a cooperative or association helps farmers to obtain information on new technologies, in this research one would have expected a positive influence of farmer membership in a cooperative or association on the adoption of LIT as highlighted in several works on technology adoption in agriculture (Bandiera & Rasul, 2006; Mariano & al., 2012). In this sense, Abdulai et al (2011) showed that in Ghana, farmers who participate in such organizations are more likely to adopt LIT.

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[7] National Initiative for Human Development

[8] National Agency for the Development of the Oasis and Argan Tree Zones

[9] Non Governmental Organization

5. Conclusion and perspective

In this study we tried to understand the extent to which institutional variables influence the adoption of LIT in the Draa-Tafilalt region. The results revealed that institutional determinants explain 59% of the total variance of LIT adoption by farmers in the Draa-Tafilalt Region and alone correctly classify 85.8% of the farms between LIT adopters and non-adopters. The results of the binary logit regression showed that four variables had a significant and positive effect on the probability of LIT adoption including three variables with less than 1% of the probability level ("access to credit", "access to subsidy" and "social influence") and one variable with less than 5% of the probability level ("contact with extension agents"). Unexpectedly, the logistic regression result also revealed that the role of the explanatory variable "membership in a cooperative or association" in the adoption of LIT in the study area is not significant.

This study has provided some answers to a little-studied problem, even though the interest of the topic seems obvious, and constitutes, to our knowledge, one of the rare empirical investigations of the antecedents of the adoption of innovations by farmers in Morocco. Through this study, we have contributed to the enrichment of the work carried out so far on the adoption of innovations in agriculture, and shed light on the institutional determinants of LIT adoption in the study area. For, and despite the plurality of research work on this topic mainly in the Anglo-Saxon and Francophone contexts, it remains little studied in the Moroccan context or even non-existent. Hence the contextual vision offered through this study.

Although this study focuses on the adoption of LIT, which is considered a radical innovation, the process is based on the introduction of a new irrigation method involving technical and material means and aiming at improving productivity through the efficient use of water. Other studies on the adoption of different types of innovations: product, process, organizational or marketing innovation would also be important to carry out. They will provide a comprehensive understanding of the determinants of agricultural innovation adoption for the development of an integrative predictive model of innovation adoption in Moroccan agriculture.

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