Effect of changes in the institutional structure of irrigation water property rights on the willingness to pay of farmers for water: case of Tunisia

Frija A., Chebil A, Speelman S., and Van Huylenbroeck G.

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Frija A.[1], Chebil A.[2], Speelman S.[1], and Van Huylenbroeck G.[1]

[1] Ghent University/Department of Agricultural Economics, Gent, Belgium
[2] Institut National de Recherches en Génie Rural, Eaux et Forets (INRGREF), Ariana, Tunisie

Abstract— **This paper assesses the economic value of changes in the attributes of farmers' irrigation water property rights in Tunisia. Changes on attributes generated by the transfer process of the property rights from the collective to the individual level in addition to changes in "constitutional" attributes were integrated into three scenarios. The valuation was conducted using the Contingent Valuation Method through the elicitation of individuals' willingness to pay. Results show positive willingness to pay values for all scenarios. However, farmers of the studied region are shown willing to pay more for changes in the constitutional attributes. Furthermore their willingness to pay appears to be most affected by their perceptions concerning the organization and the functioning of the water users' association to which they belong and by their productivity.**

Keywords— **Property rights, irrigation water, Contingent Valuation.**

I. INTRODUCTION

Many peoples use the concept of property rights (PR) in a narrow sense and equate it to the ownership of a resource with the ability to completely and exclusively control it. Property rights can however be better understood as overlapping "bundles" of rights [1]. These bundles of rights can be broadly defined as use rights of access and withdrawal, control or decision-making rights to manage the resource, exclude others from it, and to alienate, or transfer the resource to others (see [2]). This later definition provides an important set of descriptive criteria of property rights on which we'll focus later in our study. Property rights of a specific resource can at the other hand also be less complete than described in these definitions. For example, owners can derive only some value from an asset, exclude only some people from using it, or transfer only certain uses for a specified time period. Often, irrigation water property rights are of this type of incomplete property rights

A very consistent approach for classifying property right regimes consists of restricting the nature of the decision-making entity holding the rights to use a particular resource [3]. Thus, private property corresponds to a single decision-making entity such as an individual person or firm; common property to a finite collective entity such as a cooperative group; state property to a government entity; and open access to the absence of any entity with decision-making power over a resource. In this framework, it is possible to encounter situations where multiple types of parties simultaneously hold decision-making power over a resource. Ostrom (1990) [4] defines this property right hierarchy as a system of nested institutions.

Combining the definition of property right attributes (criteria) and the nested institutions aspect; we can remark that different property rights, with different characterizations, can be transferred from one institutional level to another in periods. The objective of the current study is to focus on the specific transfer of rights from the collective to the individual level and to analyze the efficiency of this transfer operation as well as the efficiency regarding some specific constitutional criteria[1] of the individual property rights obtained. Explicitly, we classify property right attributes that will be studied into two groups; (i) attributes related to the transfer operation or how well Water Users Associations (WUA) transfer rights to farmers which influences the *stability* of the right, and (ii) attributes specified by constitutional laws such as quantification of the right (in the form of *quotas*) and the *transferability* of the right.

1. By constitutional criteria we mean criteria that are precised by constitutional laws and mentioned in the Water law.

In fact, many studies have tried to assess the relationship between the property right system and the ultimate use of a particular resource quantitatively. However, in cases where property right markets are absent, no information is available neither on the economic value of specific rights nor on the marginal return of them. It is however known that consumer preferences' for environmental and natural resources can be indirectly estimated through non-market methods (by the creation of a hypothetical market). These methods can be used also to elucidate the outcome of policy reforms and changes in current situations. Contingent Valuation Methods (CVM) using the concept of willingness to pay (WTP) and/or willingness to accept (WTA) measures are among the most used methods.

The method applied in this study consists of eliciting the economic value among Tunisian irrigators using CVM in order to investigate the potential benefit of a hypothetical change in the property right system. Thus, WTP questions are used to value the specific outcome of policy scenarios intended to improve the individual irrigation water property right regarding the three attributes (criteria) mentioned before. The three policy scenarios chosen were (i) improvement of the *stability* of the right (reflecting the efficiency of the transfer operation from WUA to farmers), (ii) introduction of quantification (quotas) of the right, and (iii) adding *transferability* to the second scenario. The main assumption is that an institutional change concerning the property right attributes corresponds to an increase in the utility of the consumer as well as in society's welfare. The evaluation criterion consists of comparing the estimated economic value of water in each scenario with the price currently charged to irrigators. Any positive deviation is considered as economic rent, which is wasted.

The paper is divided into four further sections. The first one gives an overview of the literature regarding the relationship between property right systems and efficient resources use. The second section presents the CVM used. The third section describes the empirical application and the last section will present some statistical, economic, and institutional interpretations of the results obtained.

II. LITERATURE REVIEW

Few studies have reviewed the relationship between legal rights and the economic allocation of goods ([5]; [6]; [7]; [8]). Nevertheless, it is interesting to explain how different kinds and property right system affect individual behavior and the functioning and the efficiency of the economic system. Property rights can be defined as "the claims, entitlements and related obligations among people regarding the use and disposition of a scarce resource" [9]. In general, the importance and the enforcement of property rights increase with respect to the scarcity of a given resource. As a resource becomes scarcer and competition increases, property rights can clarify expectations and thereby reduce conflict and interaction between users over the resource. Demsetz (1967) [10] mentions that a primary function of property rights is that of guiding incentives to achieve a greater internalization of externalities. A situation where incentives are absent or not well defined, can be translated in a situation of incertitude, which affects the decision making of the property right holder.

For natural resources, there are multiple levels of property rights, starting with broad powers of state or national (regional) government to control the use of the resource, and ending with powers of individual users to control it. When devolution programs do transfer of rights over resources to a user group or a local government, that institution becomes the gatekeeper determining individuals' rights over the resource [1]. For the case of irrigation water, after failing to effectively manage irrigation systems centrally, many governments are now undertaking decentralization and devolution programs to transfer responsibility of the management to local governments and users' groups. Taking into account that these groups, generally known as water users' associations, become the gatekeeper determining individuals' irrigation property rights, two important aspects related to property rights in irrigation management decentralization programs must then be mentioned and studied. The first one concerns the composition and the characterization of the property right bundles transferred: what is exactly transferred, both in terms of the water resource as in terms of other goods and services related to the resource? The second aspect is related to the operation of the transfer: how well are

the property rights transferred from the collective to the individual level both in time and location?

The response to these questions determines the final qualification of the individuals' property right on irrigation water and consequently its decision making, which is function of the incentives provided. Moreover each question is related to specific attributes of the property rights.

Specific constitutional attributes can be considered as these that are fixed by constitutional laws and that are different according to countries or local governments. Specification of the transferability of the right, the duration, and the frequency, and quantification of the right can be considered as examples of such attributes. Performance of the water delivery system in terms of efficient operation and management are a second set of property right attributes. Various performance indicators were proposed in literature ([11]; [12]; [13]; [14]). Adequacy, efficiency, dependability and equity are performance objectives considered when evaluating irrigation water delivery. For example, the dependability criterion expresses the ability to provide water at the right time and in the right place. Unreliable water distribution is quoted as a major reason for low performance of irrigation systems [15]. A similar conclusion can be drawn for the other performance criteria. Low levels of these indexes may cause confusion and conflict among farmers leading to a low economic valorization of irrigation water.

III. METHODOLOGY

The economic value assessed for particular less substitutable goods or resources including various public goods, is different according to the property right regime defined on it. It is therefore argued that the WTA/WTP ratio, for environmental and natural resources, depends on the individuals' perception about the PR on these resources [16]. It also means that people are willing to pay more when their property right over a given resource is clearer ([5]; [17], [18]). Thus, in this study we suppose that the opportunity of PR enhancement can be evaluated by non-market methods and assessed using the individual preferences. Few studies have applied CV for assessing PR improvement in the case of absence of markets for such rights. To our knowledge, the most important one is the one of Herrera et al. (2004) [18] which has undertaken an efficiency analysis of PR in Ecuador and finds that the WTP of farmers is positive when improvement of their rights is suggested. Stated preference methods were also applied by Chebil et al., (2007) [19] to assess the efficiency of an irrigation delivery system in Tunisia. They found that irrigators were willing to pay more than current water rates if the stability of their rights were to be improved.

In this paper, we hypothesize that an institutional change of irrigation water property right attributes makes farmers more willing to pay for the water resource. We suppose hereby that in the Tunisian case, the current water property right bundle is inefficient and that an improvement in characteristics of water usage right, can generate an additional economic rent. The evaluation criterion consists of comparing the resulting water economic value with the current price paid by irrigators. Any deviation can be considered as an economic rent, which is exhausted. The single bounded CVM, based on dichotomous questions, is used to assess farmers WTP for scenario of institutional change. A logit model is specified for this estimation.

A. Scenarios simulated

In our case, and based on a review of empirical studies of the irrigation water sector in Tunisia ([19]; [20]; [21]; [22]), we found that instability of irrigation water supply due to water scarcity and technical problems in the irrigation network, is an important factors that affects the perception and even behavior of farmers. In addition, farmers have no idea about the total quantity of water that is allocated to them at the beginning of the agricultural season. Furthermore, the usage property right is not transferable among farmers or among farmers and WUA. Irrigators have to use their right otherwise they loose it.

We believe that insecurity in water supply stimulates farmers to overuse water when getting access to it. This hypothesis can be implicitly understood as an expected positive farmers' willingness to pay for a stabilization of their usage right over time. The same assumption can also be used to justify the choice for quantification of the right. In fact, a clearer and a fixed right can simply be synonym

for a more secure right. However, concerning the transferability, it is well known that this attribute constitutes an incitation to farmers, which can expect potential benefits from selling or buying water among them. As proved by many studies around the world, water markets are seen by policy makers as important tools to improve efficiency in water resources allocation. It is thus interesting to have information about farmers' willingness to pay for such institutional change because this information should be integrated in the cost-benefit calculation of institutional alternatives.

According to this, three scenarios are defined, making assumptions concerning the performance of WUA in water delivery services and concerning institutional policy changes. Given the specific objectives of the study, attributes of the property right integrated in the scenarios can be divided into two types. The first type reflects the efficiency of the property right transfer process and contains the "stability of the right" attribute. This attribute is generally determined by the WUA performance[2]. Thus, the first scenario supposes an improvement in the stability of water supply leading to a better stability of the right. The second type of property right attributes contains, a constitutional attribute namely quantification and clarity. According to this, second scenario simulates an institutional change resulting in a shift toward a quota system which allows farmers to have an idea about fixed quantities that they dispose during the agricultural seasons. Finally the third scenario adds transferability of the property right to the second scenario.

B. Area of study and data collection

The Cap Bon is located in northern Tunisia and is bounded in the East by the Mediterranean Sea. In 2004 around 22% of total populations in the Cap Bon region are employed in the agricultural sector. According to the CRDA Nabeul (2006) [24], main crops produced in the region are fruits (60,500 ha), cereals (53,000 ha), and vegetables (35,000 ha). Total agricultural production of Cap Bon contributes with nearly 15% to the total national agricultural production. The number of farms in the region is about of 32,000 (6.6% of total Tunisian farms). Total agricultural area of the region is 256,500 ha, of which 183,000 ha are arable land and 41,000 ha are irrigable lands. 25,500 ha (92% of total irrigated area) are equipped by a public irrigation network and the remaining area is irrigated from dams and other private sources. Currently, irrigated areas in Cap Bon are about 13.3% of the total Tunisian irrigated lands. 71% of these irrigated areas are belong to small and average-sized farms.

The valuation experiments were carried out on 66 farmers belonging to two different water users associations in the Cap Bon region described above. Table 1 presents the main descriptive statistics of the survey data including the demographic and economic characteristics used as explanatory variables in the extended logit model.

Table1. Sample descriptive statistics

Variables	Mean	St.Dev.
- Age in year	49.31	13.05
- Years of formal schooling	8	5.86
- Gross Margin/hectares (TND[3]/ha)	1788.44	1274.12
- Irrigated Area in hectares	5.42	11.78
- Water consumption in cubic meters	5818.6	4534.05
- Satisfaction concerning the functioning of WUA (percentage)	56	-

IV. RESULTS

A. Willingness to pay

The estimation of the dichotomous question was made using Stata 9 software. Table 2 shows coefficients of the estimated Hanemann models[4]. These coefficients allow calculating the mean of the

2. Given that GIC's performances are different, the PR attributes and the results can be different from a sample of users to another according to the GIC performance. Thus, our study and results are specific for the region and GIC studied.

3. TND: Tunisian National Dinar (1 euro = 1.75 TND).

4. Hanemann models give easy methods to estimate willingness to pay from response of the respondent and bid price. (see Hanemann, 1994 for more details).

willingness to pay: E (WTP), for each scenario using the method of Hanemann (1994).

Table2. Estimation of the Hanemann model with only the bid price as independent variable

Dependent Variable: Willingness to pay (binary choice)			
	"Stability" model (1)	"Clarity" model (2)	"Clarity + transferability" model (3)
Independent Variables			
Constant	0.76 (0.30)	0.34 (0.46)	1.66 (2.54)**
Bid price	-53.66 (-2.86)***	-50.41 (-2.51)**	-45.76 (-3.59)***
WTP (TND)	0.014	0.006	0.036
Log-likelihood	-25.80	-23.40	-34.39
LR	11.37***	9.66***	17.40***

Table 2 shows that the WTP for an improvement of the stability of the water provision in the studied area is around 0.0143 TND (29.7% and 21% of current water prices respectively in Fondok Jdid (FJ) and Lebna-Barrage (LB)), which still a weak value according to what water prices should be if considering increasing rates planed by government (15% of increase per year, in nominal term). New aggregated prices of water become 0.062 TND in FJ area and around 0.082 TND in LB irrigated district. The obtained value shows that the problem of water provision instability apparently does not affect farmers deeply in the studied areas. Weak value of WTP can also be explained by the descriptive characteristics of both studied regions. In fact, most of the farmers of FJ district have a well in their farms. The survey shows that 98% of farmers in the FJ district have well in their exploitation while this rate is only around 6% in LB irrigated area. Most of the positive WTP were recorded in LB area where the current price of water still higher compared to the first region.

Clarification and fixation of water quota (quantity) at the beginning of the agricultural year looks to be a non-acceptable change by farmers. Recorded WTP for this scenario was positive but only around 0.0068 TND. New aggregated prices become 0.054 TND and 0.074 TND respectively in F-J and L-B areas, which corresponds to an increase of respectively 14.1% and 10%.

Finally, relevant results concerning a positive and significant WTP value of the surveyed farmers were assessed after adding a transferability option of their property rights to the second scenario (quotas). WTP for this scenario was around 0.0372 TND (77.5% of FJ current price and 54.7% of current prices charged in LB area); aggregated prices resulted in both regions become 0.083 TND and 0.105 TND respectively in FJ and LB. This last value indicates that an institutional change concerning an enhancement of the usage right attributes toward a water market corresponds to an increase in the utility of consumer. Positive gaps between the resulting economic value of the WTP for transferable water property rights and the price currently charged to irrigators can be considered as an economic rent which is exhausted.

B. Reasons for WTP responses

In order to find which characteristics affect the farmers' WTP, an extended logit model regressing a set of explanatory variables was estimated. Explicative variables chosen were: age of the farmer (in years), schooling (number of years), Gross Margin (GM) per hectare (in TND), irrigated area (in hectares), the water users association to which the farmer belongs (dummy variable), satisfaction concerning the WUA to which the farmer belongs (dummy variable), and total consumption of water (cubic meters).

Table 3 shows the effect of each explicative variable cited above on the acceptance of the bid price in each model. As predicted by theory, the bid price is negatively correlated to the WTP value for all models. Total aggregated Gross Margin (GM) per ha is also positively and highly correlated to the WTP value for all models. An important finding concerns the negative and significant correlation between total irrigated area and WTP in stability and clarity models. This suggests that when irrigated areas are larger, farmers WTP, for an improvement in the stability of water provision and for a clarification of the right at the beginning of the agricultural season, decreases. This finding indicates that larger farmers seem to have no problem of water provision and water property rights in general. This reinforces a result found by Chraga and Chemakh (2003) [20] concerning the special treatment of their demand inside WUAs because of their social weight and power. At the other

hand, this variable affects, the WTP for institutional change toward a water market positively, but not significant.

Table3. Econometric results of the estimated logit model

Dependent variable: Willingness to pay (binary choice)			
	"Stability" model (1)	"Clarity" model (2)	"Clarity + transferability" model (3)
Independent Variables	Coefficient	Coefficient	Coefficient
Constant	-8.635 (-1.76)*	-5.678 (-1.60)	-7.96 (-2.09)**
Bid price	-103.006 (-2.30)**	-92.655 (-2.78)***	-71.92 (-2.15)**
AGE (years)	0.064 (0.83)	0.054 (0.91)	0.037 (0.73)
SHCOOLING (N° of years)			0.438 (2.27)**
Gross Margin /Ha (Productivity)	0.0014 (2.45)**	0.0014 (2.50)**	0.0017 (2.69)***
IRRIGATED AREA (ha)	-0.377 (-2.00)**	-0.416 (-1.92)*	0.057 (0.64)
WUA (dummy variable: 1: Lebna Barrage; 0: Fondok Jdid)	3.21 (1.66)*	1.62 (0.98)	-2.25 (-1.03)
SATGIC (satisfaction concerning the internal GIC functioning)	6.79 (2.87)***	3.94 (2.55)**	
CEAU (total water consumption m3)			0.0004 (2.28)**
- Log-likelihood	-11.62	-23.4	-34.39
- LR	39.74***	9.66***	17.40***
- MC Fadden R-squared	0.36101	0.51497	0.83952
- Percentage of correct *predictions*	94.02 %	89.55 %	91.04 %
Info Criterion (minimum values):			
- Akaike	0.5558	0.6177	0.63003
- Schwarz	0.5267	0.5682	0.5984

The dummy variable related to the satisfaction of farmers, concerning the functioning of WUAs, affects their WTP for the first two scenarios significantly and positively. Total water consumption and number of year schooling are two variables which positively and significantly affect WTP in the third model implying that high water consumers and the most educated farmers are willing to pay more for transferable water property rights.

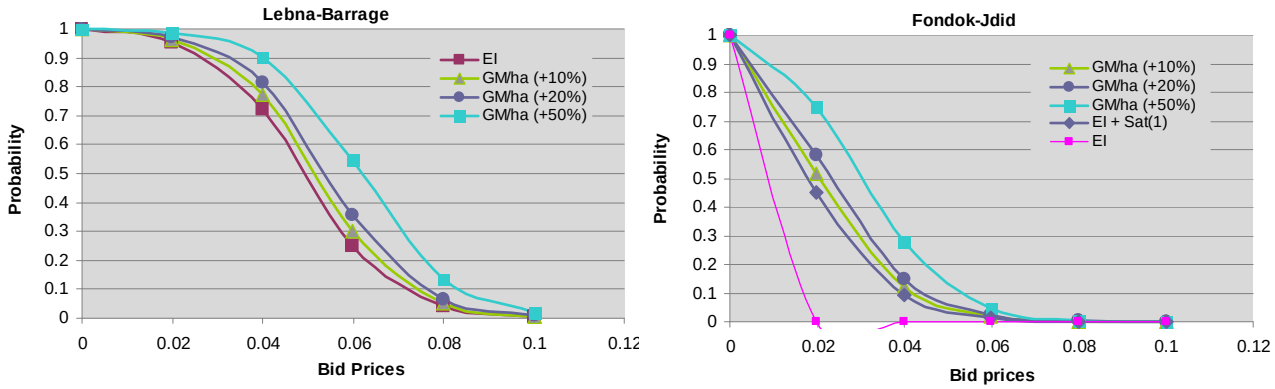
C. Analysis of the probability of acceptance

In this section we try to analyze the effect of changes in relevant variables from the previous section, on the probability of acceptance of higher prices of irrigation water in the studied areas. Two changes (change in gross margin per ha, and change in the satisfaction concerning the functioning of the WUA) were integrated in three sub-scenarios. The initial mean values of the studied sample described in table 1 are taken as the initial situation and then equation (5) is calculated for the following changes:

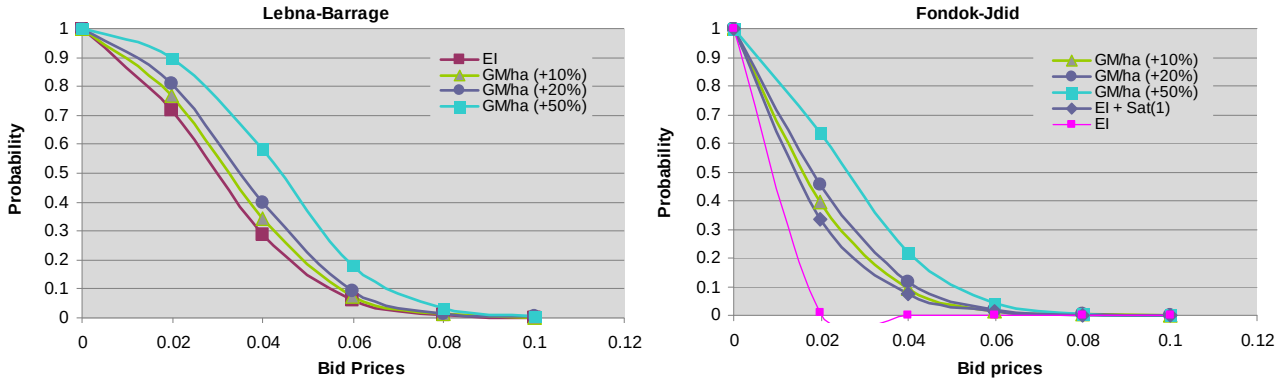
- Initial situation plus changes in satisfaction dummy variable (from 0 to 1) for farmers of FJ area. We mention that only 26.4% of FJ farmers are satisfied about the functioning of their WUA, while this rate is around 84.5% in LB. For this reason, the initial situation in FJ area is regarded as non satisfaction.
- Initial situation plus an increase of 10, 20 and 50% in the gross margin per hectare reflecting an increase of the farmers' productivity after an agricultural policy intended to improve this index.

Only the second sub-scenario was applied for the third model (quotas + transferability of the right) which regress different variables than regressed in models 1 and 2.

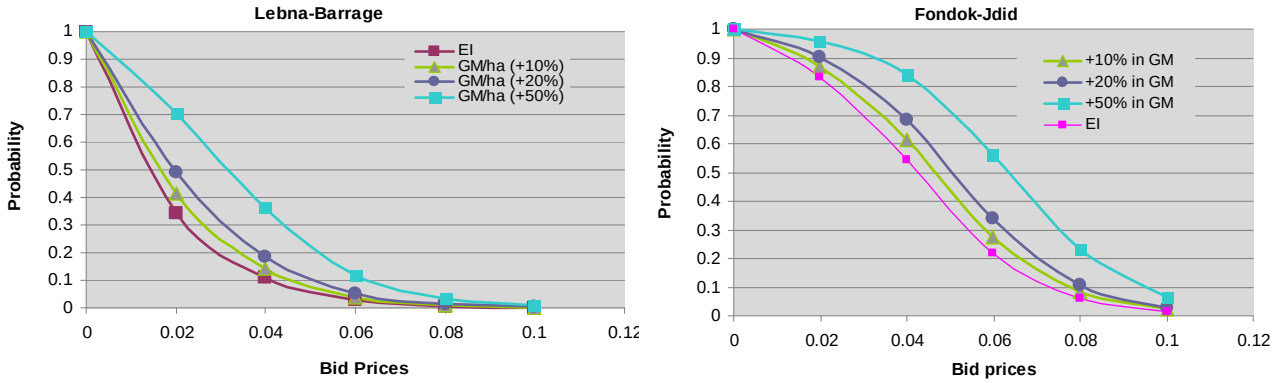
Figure 1 reflects the same trend mentioned in previous sections concerning the difference between the acceptance levels of each scenario. However, it also shows that an improvement in the perceptions of farmers concerning the organization and functioning of their WUA in addition to an improvement in productivity of rural areas are important factor to consider in a pricing policy intended to increase the prices of irrigation water progressively.



1. Stability scenario



2. Clarity Scenario



3. Clarity + transferability scenario[5]

Fig. 1 Effect of the productivity and the organizational environment on the predicted probability of accepting the bid prices. (*EI: Initial Situation; GM/Ha: Gross margin per hectare; Sat: satisfaction*)

5. Variables used in the model 3 are different from these used in the two first models. This means that a comparison between trends of curves in the first two scenarios and the trends in the last scenario are not valid.

In fact, for the two first attributes (model 1and 2), it is clear that there is more chance that higher water prices could be accepted in LB area than in FJ. Descriptive analysis of the survey explains this difference. About 36.4% of farmers in LB are not satisfied with the current state of the WUA' irrigation network while this rate is only around 6% in FJ. Furthermore, 15% of farmers in LB consider lack of water at the moment they need it urgently as a main irrigation constraint. However, in FJ 36% of the farmers considers quality of water as a main irrigation constraint. It is interesting to mention that under the improvement of property right stability scenario, a change in the satisfaction variable of farmers in the region of FJ increases the probability of accepting a price increase of 0.02 TND from near 0 to more than 0.4. When adding an improvement of 50% of their average productivity, this probability even increases to about 0.75.

The same effect of the productivity on the probability of acceptance of higher prices was also drawn for the third scenario, where improvement of the farmers' productivity generates higher probability of accepting higher water rates for transferable rights. However, it is important to mention that farmers in FJ area are willing to pay more for this scenario. This can be related to the availability of additional water sources and storage infrastructure on their farms. Education level is also higher in FJ farmers surveyed. Nearly of 44% of FJ farmers have more than 10 year schooling, while 61% of LB farmers have less than 6 year schooling.

V. CONCLUSION AND POLICY IMPLICATIONS

This paper estimated that the value of improving irrigation water property rights in Cap Bon region in Tunisia is respectively approximately 25, 12, and 65% higher than the average water rates in the region for an improvement of the stability, clarity and transferability. The estimation was done using a single bounded CVM which has been shown to be reliable for assessing the value of PR of irrigation water.

Results show also that the current system of usage PR of irrigation water in Tunisia can be considered as inefficient compared to other systems. Improved systems containing more efficient attributes of PRs could help reaching higher rates of cost recovery of irrigation water production. It is necessary to analyzes opportunity costs of any institutional policy changes before taking decisions for shift.

The inefficiency of the property right transfer process from collective to individual level, which varies according to the physical, technical and financial performances of the WUA, wasn't large in our case study. However, it was clear that the perfection of this process leads to a higher valuation of irrigation water from farmers. This result confirms results found by Chebil et al., (2007) [19] in another irrigation system in Tunisia.

Many factors were found to be explicative of the farmers' WTP. The bid price, the gross margin per hectare, total irrigated area, water consumption level per hectare, and the satisfaction concerning the organization and the functioning of WUA are among the most important. This proves the fact that farmers' perceptions of the local governance inside WUA affect deeply their willing to pay higher rates of water and to accept changes. It will be necessary to improve the confidence, transparency and accountability inside WUA before proposing pricing policies.

Pricing policies applied separately from other rural and agricultural policies can be unacceptable. Better results of such policies can be drawn when accompanied for example with an agricultural policy intended to improve the productivity of farmers. The effect of the productivity on the WTP was also proved, by Chebil et al., (2007) [19], to be significant in explaining willingness to pay of the horticultural farmers of Teboulba region in Tunisia.

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