The economic value of guaranteed water supply for irrigation under scarcity conditions

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1. Introduction

Pressures on water resources in regions with scarcity makes water planning a difficult task to search a compromise between objective of guarantee water supply to economic uses and simultaneously reaching environmental goals regarding quality and quantity of water for the environment. Water is an economic good (ICWE, 1992; SWWF, 2000; Rogers *et al* 2002; Hanneman, 2006) and the proper water management requires well defined water rights systems as a requisite for sustainable management of increasingly scarce water supplies (Matthews 2004). The implications of considering water as an economic good relates primarily to recognizing that when water is scarce, allocation decisions should take into account benefits to users, the costs of service provision, and forgone benefits to potential users (Hellegers, 2006).

Rising water demands are difficult to meet in many regions of the world. Agriculture is by far the largest user of water, accounting for approximately 70% of freshwater abstraction in the world (FAO-COAG, 2007). World's irrigated agriculture will have to face the increasing uncertainty about the quantity and regularity of the water supply caused by global climate change (UNESCO-WWAP, 2009). Climate change is expected to account for about 20% of the global increase in water scarcity (FAO, 2007). Additionally, the foregone decrease in precipitation is expected to increase the demand for irrigation water (IPCC, 2007), increasing the pressure over the resource.

Irrigated agriculture, often considered the least profitable economic sector, provides society not only marketable goods (commodities) but also public goods of an environmental and social nature (non-commodities) (Kallas *et al*., 2006). It supports economic development in rural areas, providing jobs and supporting agro-food industries in areas that would otherwise become depopulated (OECD, 2002). In Europe, the achievement of the Good Ecological Status that imposes a minimal environmental flow (enforced by Water Framework Directive (WFD) 2000/60/EC), together with the already existing constraints to the use of water for irrigation derived from climate variability, climate change and competing demands, puts irrigation water allocation rules at the core of the challenges for water management and the provisioning of those services.

For this purpose we look at the case of irrigation farmers in Southern Spain. The issue is of importance because of the period of transition that Spanish water policy is experimenting since the last decade (discussed in Section 2) and the scenario of uncertainty over the amount of water available to irrigation that farmers face in the most of water scarcity regions. Decades of water resource mismanagement have created pervasive pressures on water resources, resulting in severe scarcity (Albiac *et al*., 2006a, Garrido and Llamas, 2009; Font and Subirats, 2010). Measures under implementation in the new Programs of Measures derived from WFD try to introduce demand management tools but the new approach require careful application and a reliable information base, since the implementation of demand management measures is a complex process that meets with resistance from farmers (Albiac *et al.,* 2006b). Given that, this paper aims at contributing to the knowledge required in this complex process through the finding of evidences that could serve as pre-requisite for any type of flexible mechanism to work ensuring the producers a greater security in their profits in shortage periods (through water exchanges with other users or water banks among others measures).

The hypothesis tested in this research is that farmers valuate water supply guarantee to irrigation and this could imply a willingness to participate in measures that decrease the uncertainty. There is yet scarce knowledge on the economic value of the guarantee of water supply for irrigation. This study also aims at contributing to fill this knowledge gap and provide insights about farmers; perception and behaviour for a better understanding of the conditions needed for a more flexible water allocation system, through the estimation of farmers' willingness to pay for improving guarantee supply. The general purpose of the research is the better understanding on farmers' perceptions in the context of water scarcity. This is done through the application of a stated preferences' valuation study applied in the Guadalbullon River Basin in Southern Spain, in which farmers' willingness to pay (WTP) for secured water supply for irrigation is estimated. We evaluate the effect of different farmer characteristics on WTP. This additional information could help policy makers to better target their interventions by improving their knowledge about the likely support among different types of farmers for specific policy actions.

This approach has been used in previous studies to estimate the value households associate with the reliability of their water supply (Howe and Smith, 1994; Barakat and Chamberlin, 1994), to examine customer's preferences (Griffin and Mjelde, 2000; Koss and Khawaja, 2001; Raje *et al*., 2002), to study household's and business WTP to avoid drought water restrictions (Hensher *et al*., 2005), to obtain implicit prices for attributes associated with changes in the reliability of household water (Hatton McDonald *et al*., 2010), and to estimate value of decreasing probabilities of suffering water restrictions in domestic secondary uses of water (Martin-Ortega *et al*., 2010). This extensive body of literature looking at household water supply contrasts with the very scarce literature regarding irrigation water. Rigby *et al.* (2010) estimated the marginal irrigation water value to horticultural producers in Southern Spain using choice experiments. The effect of supply uncertainty of irrigation water is included in this study; however the value of this is not estimated. Alcon *et al*. (2010) carried out a stated preference study for estimating the value of the use of reclaimed waste water for agriculture, which implicitly leads to an increase of the guarantee of water supply, but this is not explicitly assessed in their study. Following this approach, a contingent valuation exercise is employed to estimate irrigated olive grove farmers' preferences for improvement of water supply in the context of their water rights system, and particularly, to investigate the trade-offs that farmer are willing to make between different levels of guarantee supply. In the context of property rights, Linde-Rahr (2008) also uses this method to obtain WTP for forest property rights and the value of increased property rights security. To the best of our knowledge, such an analysis for irrigation water has not been addressed in the literature.

The structure of this paper is as follows. A previous discussion about water rights system in Spain and case study description are provided in Section 2. Section 3 locates the study within the literature review on the economic value of water (irrigation) supply guarantee and the methods used to evaluate the relation between uncertainty over water supply guarantee and farmers' benefits exist. The experimental design, survey and data collection are described in Section 4, while Section 5 contains the results and discussion. Section 6 concludes the paper.

2. Case study description

2.1. Spanish irrigation water allocation system

Traditionally, Spanish water policy emphasized a "structural" approach to alleviate problems of drought, flooding and variability of water supplies. This approach involves regulation of the water supply by means of state-subsidized construction of large-scale infrastructure using rigid, hierarchical and top-down planning measures. Although it has not been completely abandoned, the supply-based engineering approach to water policy has lightly turned towards a concept based more on sustainability of the resource (Bhat and Blomquist, 2004; Font and Subirats, 2010).

In Spain, the use of surface water requires a *water use right* constituted by each basin's authority according to a preference use order that the 1999 Law established[1]. It is argued that the existence of positive rents by the use of water is the main reason for the huge rise in irrigation infrastructure needed for the creation and consolidation of water rights. These water rights can only be fully satisfied in exceptionally wet years while investment in the irrigation sector follows the same pace provoking an irrigation infrastructures' over-investment, i.e. overcapitalization (Gomez, 2009).

As Embid Irujo (2008) holds, the 1985 Water Law opened a new era for water policy, moving it away from the traditional structural approach. The excessive rigidity of the entitlement system made it almost impossible to introduce changes in the use of water, since a new entitlement could be requested only when another expired (Garrido, 2005). According to Bhat and Blomquist (2004), in response to the weakness of the water allocation system exposed during the 1992-1995 drought period and in order to incorporate the principles coming from the project of the EU Water Framework Directive in 1998, this law was partially modified in 1999 by the 46/99 Act. This reform combined a more rigorous control by the State upon the natural resources with a more flexible use of water (Costejá *et al*., 2004) through the regulation of the exchange of water rights and the provision for water banks (Garrido and Llamas, 2009). This promotes the contracts for the cession of use rights, so that, surplus water can be sold to other right-holders (with the same type of water use) reaching a higher level of efficiency in the use of this natural resource. Moreover, Basin Authorities can setup water banks or trading centers in cases of droughts or severe scarcity problems. However, Garrido and Rassenti (2003) based on their experimental results argued that, in general terms, the 1999 water sector reform in Spain represents a tepid step to let markets dictate the allocation of scarce water resources. Little formal water trading is happening despite of the law aimed to promote them. Possibly because of the widespread distrust of formal water market among farmers. Doubts including that these formal markets would increase monitoring, taxes and corruption make farmers reluctant to participate in them. Then, this feeling appears to be dominating the lure of potential gains from trade and in the midst of a drought, it may be feared that the willingness to sell water may be seen as sending signals that the water is not really needed (Albiac *et al*., 2006; Rigby *et al*., 2010).

2.2. The Guadalbullon River Basin

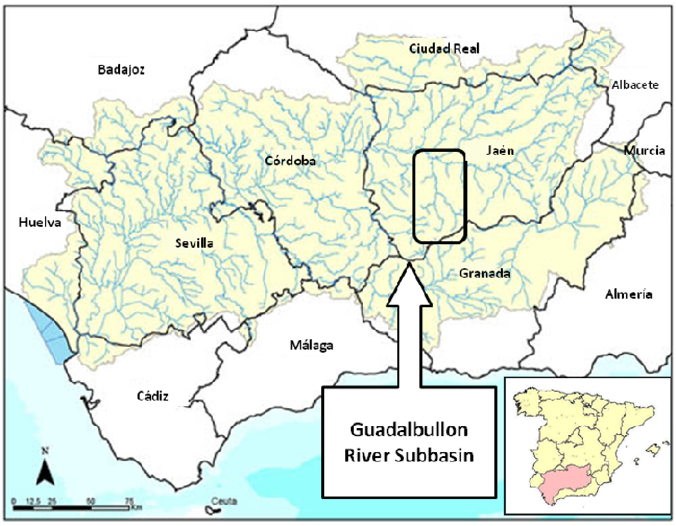
The Guadalbullon[2] River Sub-Basin area which is part of the Guadalquivir River Hydrologic Basin in Southern Spain (see Figure 1). Within the overall water deficit of the Guadalquivir River basin, the Guadalbullon River poses a special problem set as it is not a regulated river (river regulation is natural) hence presents a great variability in its flow and there are important irrigated fields on its banks, most of them olive grove. Irrigation is by far the largest use of water resources in Southern Spain (82%) with an

[1] The 1999 Law was consolidated into Law 62 of December 20, 2003, which modified the Revised Text of the Water Law passed by Executive Order 1/2001 of July 20, 2001. It also incorporates the European Parliament and Commission Directive 2000/60/EC of October 23, 2000 which establishes a community framework for action in the area of water (European Union, 2000).

[2] Guadalbullon River sub-basin was selected as a pilot sub-basin to study olive irrigation and water guarantee, as it was considered by Confederación Hidrográfica a good example of the irrigated olive characteristics for Guadalquivir Upper Valley (CHG 2009a)

increasing intra-sector competition with other users (mainly industrial, urban and tourist uses), that are projected to continue increasing by about 30% by 2015) (Martin-Ortega *et al*., 2008). This case study is relevant because is an unregulated river and is representative of irrigated olive that is the most remarkable innovation in Guadalquivir River Basin irrigation.

Figure 1. Guadalbullon River Sub-basin's location in Guadalquivir River Basin.



Source: Confederación Hidrográfica del Guadalquivir (2009b).

Summer flows have historically enabled the establishment of irrigated fields, initially located on the stretch near the junction with the Guadalquivir River that have subsequently, with the boom of irrigation in olive grove, spread throughout the valley. Given that, intersectorial shifts of water supplies are unlikely to suffice to balance demands with supply (Bhat and Blomquist, 2004).

The total area under cultivation in the sub-basin area is 70,494 ha of which 21,749 (30%) are irrigated surface and the rest is rain-fed. In the sub-basin, agriculture uses 70% of the water mainly for olive groves as single-crop farming. It is estimated that total consumption in the basin uses 65% of the renewable resources and that the minimal environmental flow is not reached in a significant number of days.

The current policy in the basin is to improve farm irrigation systems (changing from surface to trickle irrigation) and the distribution system (pressurized networks). Each farmer receives an amount of water assigned by the water authority as a 'water right' or concession. Water concessions usually are assigned at 6,000 m^3/ha; however, in the Guadalbullon River basin farmers rarely receive the full right and often the yearly quota is smaller[3]. The average volume of water allocated to irrigation has decreased during the last 20 years from 7,000 m^3/ha in the 1980s to 4,700 m^3/ha in the period 2000–2005. Irrigation of olive grove is seen as a technological revolution in the sector, especially in this region where in 2008 the percentage of olive oil coming from irrigated areas was estimated at 56% of the total. The higher profitability of irrigated olive grove per area and the increased use of family labour in small farms are some of the reasons behind the pressure to increase water consumption in the sector. Taking the Guadalquivir River basin as a whole, the olive grove has become the largest user of

[3] 6,000 m^3/ha is an average from the different administrative allocations in Guadalquivir River Basin, and it varies according to area and crop type (e.g., rice uses around 12,000 m^3/ha whereas some olive cultivation areas receive 1,500 m^3/ha).

water despite its low dose (1,500 m^3/ha versus an average of 6,000 for general irrigation). The transition of agriculture from field crops to higher-value crops, such as olive groves, may have a beneficial effect on water use efficiency, but it increases the financial exposure to drought because of the substantial capital investment in those crops (Bhat and Blomquist, 2004).

In compliance with the "Guadalbullón Sub-basin Irrigable area Modernization Plan", a small reservoir, named as Balsa Llano del Cadimo, is currently being built to regulate the flow of the main Guadalbullón river basin´s streams. This infrastructure will increase the irrigation water supply guarantee, allowing irrigation in the dry season (summer months) and is expected to increase the environmental river flow. The maximum capacity of this reservoir will be 19.75 million m^3 and it is expected allow the irrigation of around 18,000 ha of olive grove (MARM, 2007). Estimates extracted from the Balsa del Cadimo Feasibility Plan published on 11/2005 Law, estimating, for this case study, the cost of the investment in 0.12 €/m^3 (taking in account an average allocation[4] of 1,000 m^3) that would be charged to beneficiary farmers.

3. Materials and Methods

Different studies about the relation between uncertainty over water supply guarantee and farmer's benefits exist; but they are almost exclusively restricted to market values. For example, Calatrava-Leiva and Garrido (2002) show how uncertainty in water availability reduces farmer's benefits because of the fact that the decisions are taken when they are not sure about the amount of water available for irrigation; Marques *et al*. (2005) obtain that increasing water supply reliability can raise the probability of higher benefits and promote more effective use of water for permanent crops. In Mesa-Jurado *et al*. (2010) net margin variability by the profit function is obtained for different water doses applied to olive groves. Also, Rajan (2010) studies the farmer decision of whether or not to participate in the risky water markets. Nevertheless, although uncertainty is taken in account, in none of them, the non-market value generated by an improvement of water supply guarantee is estimated. This is done in this paper through the application of the stated preferences valuation study, in which farmers' willingness to pay (WTP) for secured water supply for irrigation is estimated.

As said, the existing literature in this respect relates only to household water consumption (Barakat and Chamberling, 1994; Hensher *et al*., 2005; Hatton MacDonald *et al*., 2010), however, there is a lack of research regarding irrigation supply and exist very scarce of studies about the topic, such as Rigby *et al*. 2010.

Stated preferences approach is used to estimate the non-market values. It implies the use of surveys, in which hypothetical markets are presented to a representative sample of the population. These hypothetical markets are characterized by a change in the environmental good under assessment in exchange for a certain amount of money (Bateman *et al*. 2002). Here we have used the contingent valuation method, whose design is described in detail next.

3.1. Experimental design, survey and data.

The CV design process began with the identification of policy-relevant water rights system and water supply guarantee features through a review of the literature on legislation on this topic (Costejá *et al*., 2004; Font and Subirats, 2008). Also, in-depth

[4] Data obtained from Irrigator Communities' interviews in the area study.

interviews of 18 main Irrigator Communities in the river basin that manage water distribution between the farmers and focus group discussions were made up of farmers, representatives of Irrigator communities and experts in water management (from the river basin authority). Among the goals of these interviews are to check the information given by each of farmers with the official data from these communities and achieving first-hand information about the case study because is too difficult to find the data needed for this study from the official sources. Following guidelines in Bateman *et al.* (2002) the focus group discussions and pilot-surveys (40 face-to-face interviews) are used in order to get most of the basic information to build up the questionnaire, to fine-tune the language that is required for a proper communication with farmers (among others goals) and to validate the questionnaire. During the pre-test, the most controversial topic was the lack of trust in the Administration management, and farmers' complaints because of the low prices of olive oil and the high cost of electricity for pumping water from the river to the farm.

The questionnaire used in the survey was organized in four main parts: i) information about the farm (eg. farm size, crop density...); ii) respondents' perception and knowledge about the current state of irrigation water supply guarantee in the study area (eg. certainty about the quantity of water they will receive at the beginning of the season, satisfaction with the water quantity they receive etc); iii) respondents preferences and values towards irrigation supply guarantee improvement in the basin elicited trough the contingent valuation method; iv) respondents' demographic and socio-economic characteristics and the interviewee's attitude aimed at analyzing preference heterogeneity.

The valuation scenario presented to farmers consisted of a baseline situation (corresponding to the current status quo) in which the administration assigned water allocation (1,500 m^3/ha) is not met, current lack of guarantee and the consequences of this irregularity of water supply in the production are explained. Farmers were offered the possibility to pay for an increase the guarantee of the supplied water. The presentation of the valuation scenario was supported with the use of pictograms and two mental accounts were included, one guaranteeing respondents that their money would only be used for increasing in water supply guarantee and a budget reminder. Then respondents were asked if they will be willing to pay in principle to improve the guarantee water supply in this area. For those who stated not to be willing to pay (WTP), a follow-up question was made to differentiate legitimate zeros from protest answers. Those who stated to be willing to pay in principle were asked their maximum WTP to secure a certain level of water supply for irrigation ('What is the most you would be willing to pay as an addition to your yearly Irrigators Community fee to ensure 10,000 l/olive[5]?').

The availability of water was related to a certain probability. During the pre-test it was observed that certain farmers had problems regarding probability expressed in terms of percentage that is why the guarantee of water supply was defined as the number of years that the farmers receive a specified quantity of water with certainty. This way of presenting probabilities of uncertain events have been previously applied in relation to water supply in Martin-Ortega *et al*. (2011). Two levels of guarantee were defined in order to check for sensitivity to scope; theoretically the higher the level of guarantee, the higher the amount of money that farmers are willing to pay (Carson *et al*., 2001). The first level was set up on 50% (i.e. 5 years out of the next 10 years in the

[5] For a better understanding with the farmers, the units used in the survey are liter per tree, because it is the measure that they normally use in their water counts. A water allocation of 15,000 l/tree corresponded to 1,500 m^3/ha.

language used with farmers) of guarantee of getting the offered water supply and a second level of 90% (i.e. 9 years out of the next 10 years)[6]; during the pre-tests it is was observed that a full guarantee, 100%, was not credible for farmers taking into account their knowledge about climatic conditions in the region.

The annual increase of the Irrigators community fee was indentified in the pre-test as the best payment vehicle as the respondents were already familiar with this kind of payment (expressed in euro per olive-tree). It is comparable with the increment of the monthly water bill that has been successfully applied in water resource valuation studies in the past (Genius *et al*., 2008; Martin-Ortega *et al*., 2009; Alcon *et al*., 2010). In studies such as Rigby *et al*. (2010) the payment vehicle used in their choice experiment was an irrigation contract in which different amounts of water, prices and level of certainty were offered to the farmers.

The elicitation format is a semi-open ended payment card. Quantities from 0 euro to more than 8 euro were included in the payment card (these quantities were selected so that the maximum quantities were greater than the maximum amount respondents were willing to pay in open-ended questions in the pre-tests). The NOAA panel advises on the use of dichotomous choice elicitation formats (Arrow *et al*., 1993), and that open-ended format data can lead to upward biased WTP estimates, but this kind of elicitation format combines the advantages of the open-ended formats at the same time it minimizes the problem of starting point bias (Kallas *et al*., 2007). Moreover, the opened formats let to work with smaller samples and Ready *et al*., (2001) argued that this kind of format shows the quantities that respondents are willing to pay with higher certainty.

One hundred and fifty one face-to-face interviews were conducted by expert interviewers in July 2009 throughout the Guadalbullon River Sub-basin, targeting a random sample of irrigated olive farm owners belonging to sixteen different Irrigator Communities distributed across the sub-basin.

4. Results and discussion

4.1. Farmers' characteristics

The main demographic and socio-economic characteristics of the sample are presented in table next. Descriptive results show that a high number of farms are small sized (0.1-5 ha), reaffirming the high atomization of the sector in this region. The average density of the olive grove corresponds with the traditional system, in which the number of trees varies between 70-110 trees per hectare. Related to the age of the respondents, table 1 shows that around fifty percent both in the sample and in the population are older than 55 years; young farmers only represent a seven percent of the respondents. Almost the half of the respondents has elementary formal education, remarking that a high percent of them lacks of studies. The distribution of the income shows that around thirty percent of the farmers have an annual household gross income under 20,000 euro, thirty eight percent have between 20,000-40,000 euro and fourteen percent have between 40,000-60,000 euro; the rest have higher incomes. Fifty percent

[6] To control for ordering effects (i.e. the potential effects on stated WTP of first asking for 50% of water guaranteed and then 90%) (Bateman *et al*. 2002), two versions of the questionnaire were prepared and presented to a split sample. In the first version, farmers were first asked about their WTP for a 50% guarantee and then the 90% guarantee. In the second version, the order was reversed and farmers were first asked about their WTP for a 90% guarantee.

of farmers depend on agriculture as the only source of income while 28% of the respondents reported that it is a secondary activity contributing between 20-50% of their incomes.

Table 1. Farmers' characteristics

Characteristics	Sample	River Basin Population
Farm size distribution (%)		
0.1-5 ha	65.6	68.0
5-10 ha	19.2	15.9
10-20 ha	9.3	8.3
20-50 ha	4.6	4.5
>50 ha	1.3	3.2
Average irrigated production (kg/ha)	4,560	5,056
Average olive density (olive/ha)	109	117
Age distribution (%)		
< 35 years	7.3	9.9
35-54 years	42.4	38.6
54-64 years	24.5	23.3
>64 years	25.8	28.3
Education (%)		
Without formal education	28.5	18.3
Elementary school	49.0	43.9
Secondary education	15.9	20.6
Higher education level (university)	6.6	17.2
Household size (persons)	2.92	2.83

Source: National Institute of Statistics, 2010. Data for the Jaen region, where the 100% of the river basin is found.

In the overall, the sample is a fairly good representation of the farmers' population, differences are not significant.

4.2. Perceptions on water supply

Water supply guarantee is considered to be a very important issue for most of the sample respondents. Over 65% stated that they are ignorant at the beginning of the season of the water that will be available to them for irrigation and almost fifty percent felt that there is, in general, insufficient water for their farms. Farmers stated, on average, that they received 9,000 l/olive in the last four seasons, which is far below the 15,000 litres/olive to which they are entitled by the administrative water concession. Almost 96% declared that irregularity of irrigated water supply causes negative effects in productivity of olive.

It is interesting to observe that farmers (22%) could not answer exactly how much water they receive each year. The quantity of water they perceived to be receiving was lower than the actual one declared by the Irrigators Community in 55% of the cases and only an 11% perceive a higher quantity, so their perceived difference is actually even bigger than the real difference.

Other important questions were about the Irrigators Community's fee in order to compare these data with the WTP. All interviewed farmers remember this piece of information. The average fee paid by the farmer per olive is 3.56 €, this quantity varies between one and six euro depending on the Irrigators Community.

4.3. Willingness to pay and preference heterogeneity

Farmers were asked first about their willingness to pay to improve the guarantee water supply for irrigation without mentioning any guarantee level. Over 29% were unwilling to pay anything. From the total of the negative answers, the 79% was classed as legitimate zeros and the 31% (6% of the sample) was considered protest responses. The main reasons given by those unwilling to pay were; "the State has to pay it" that represents 89% (5.3% of the sample). According to common practice in the literature, the protest responses were excluded from the analysis and the legitimate zeros were kept (Dziegielewska and Mendelsohn, 2007).

Table 2 shows the descriptive statistics of the responses about WTP to improve the guarantee water supply for irrigation for the two levels of guarantee (50% and 90%),. Mean WTP to ensure 10,000 l/olive 5 out of 10 years (50% guarantee) results in 0.39 €/olive per year, and to ensure 9 out to 10 years (90% guarantee) is 0.74 €/olive per year.

Table 2. Willingness to pay to improve the guarantee water supply for irrigation for 50 and 90% level

	WTP to ensure 10,000 l/olive five out to ten years (50%)	**WTP to ensure 10,000 l/olive nine out to ten years (90%)**
Valid observations	141	141
Mean	0.39	0.74
Median	0.30	0.60
Standard Deviation	0.38	0.63
Minimum	0	0
Maximum	1.5	2.8

In order to make comparable these values, a change of units is made. Litres per olive are changed to cubic meter per hectare (taking in account a density of 100 trees/ha).

If it is taken in account that the little reservoir Balsa del Cadimo's cost of investment is estimated in 0.12 €/m^3 for an average allocation of 1,000 m^3/ha (it would be charged to beneficiary farmers) and that the WTP for the same allocation is between 0,04 and 0,07 €/m^3, for 50% and 90% of guarantee respectively, it implies the flexible measures could be more convenient for the farmers, as structural measures like Balsa del Cadimo are not as legitimate as the other ones. It might be possible that the farmers would be reluctant to finance them.

The analysis presented previously is an univariate analysis in which only the variable "willingness to pay" is analyzed. Following the objectives of this research, heterogeneity of demand for the improvement of irrigation water guarantee has been analyzed in terms of the socioeconomic characteristics of respondents as well as in terms of the characteristics of their farms. In the case of contingent valuation where there is a large of accumulation of zero values, standard linear regressions (OLS) provide inconsistent WTP values (Seung-Hoon *et al*. 2000). In this study, following the example of Amemiya (1984), Halstead *et al*. (1991), Alcon *et al*. (2010) and Adams *et al.* (2008), a Tobit model has been proposed instead.

Different variables considered in the questionnaire were tested in previous stages of the model development in order to observe their influence in the WTP. In table 3 variables that are found significantly influential in the WTP are shown with a brief description and their coding. Besides socioeconomic variables like annual household gross income, age, household size or agricultural training related to the farmer characteristics, variables concerned with farm description, such as density of tree, perceived water dose and rainfall production, and aspects of the questionnaire difficulty are considered in the analysis. Variables such as education level, proportion of incomes from agriculture, geographic situation of the farm, farm size and irrigated production have not significant influence in the WTP.

Table 3. Description of the variables used in the model

Variables	Description	Codification
Id WTP	Identify the level of guarantee is 50% or 90% for the question of Willingness to Pay.	0 = guarantee 5 out to 10 years 1 = guarantee 9 out to 10 years
CLUSTER	Identify the respondent for testing pooling procedure	Continuous variable (1 to 151)
INCOME	Household gross income per year	Categorical variable
AGE	Identify if the age of the farmer is more or under 42 years old	0 = Less than 42 years 1 = More than 42 years
HOUSEHOLD SIZE	Number of persons dependent of farm household income	Continuous variable (1 to 6)
AGRICULTURAL TRAINING	The farmer has undertaken an agriculture training (pesticides, ecological agriculture…)	0 = Yes 1 = No
OLIVE PER HECTARE	Number of olive trees per hectare	Continuous variable (70 to 203)
PERCEIVED WATER DOSE	Quantity of water received as perceived by the farmer (l/tree)	Continuous variable (600 to 15,000)
RAINFALL PRODUCCION	Kilograms of olive per hectare produced in rainfall system	Continuous variable (500 to 5,000)
DIFFICULTY OF THE QUESTIONNARIE	Level of difficulty of the questions according the farmer's opinion	1 = very easy to understand it 2 = easy to understand it 3 = more or less to understand it 4 = Difficult to understand it

Results of the Tobit model are reported in table 4, in which it is possible to observe the variables that influence WTP for improve the guarantee of water supply. As the pseudo R^2 is above 0.2 the overall model fit is considered good (Hensher and Johnson 1981).

Table 4. Results of Tobit model.

Variable	Coef.	p-value	Std. Error
Id WTP	0.395	0.000***	0.087
CLUSTER	0.0007	0.484	0.001
INCOME	0.163	0.002***	0.053
AGE	-0.251	0.037**	0.119
HOUSEHOLD SIZE	0.072	0.053**	0.037
AGRICULTURAL TRAINING	0.239	0.024**	0.105
OLIVE PER HECTARE	$- 3.331 \cdot 10^{-3}$	0.058**	0.002
PERCEIVED WATER DOSE	$- 4.58 \cdot 10^{-5}$	0.020**	0.000
RAIN FED PRODUCCION	$5.43 \cdot 10^{-5}$	0.148	0.000
DIFFICULTY OF THE QUESTIONNARIE	-0.145	0.110	0.089
Constant	-0.51	Pseudo-R^2	0.32
Num. Observations	302	Log likehood	-199.98

Notes: Statistical significance levels: ***1%; **5%: *10%.

As theoretically expected, sensitivity to scope is confirmed in this case (ID level variable significant at the 1%).

The variable relating to income has the expected positive sign, implying that the respondents with higher gross income per hectare are willing to pay more for the improvement of the service than farmers with lower income. At the same time, farmers with a larger number of olives per hectare are less willing to pay, which is not surprising since, the fee proposed here is per olive, and therefore, the total costs per hectare for these specific group of farmers is higher. Agricultural training usually implies a higher productivity of labour and more innovative behaviour, and this may explain the positive relation between this variable and the WTP value.

A significant negative coefficient is found for the age; young farmers are willing to pay more than older ones. Also, respondents who have more people dependant on the farm's income are willing to pay more. We interpret this as a stronger need for ensuring their production, i.e., a higher need for income certainty. It could be interpreted as the guarantee implying stable incomes for them, so it confers a higher security for their families' maintenance.

It is estimated with a negative significant coefficient that farmers with a lower perceived water dose are more interested in guarantee supply. It was tested during the model elaboration that this significant relation does not mean that they are thinking about receiving a bigger quantity of water, because a variable that represents the differences of perceiving water doses between farmers has a not significant relation with the WTP value.

5. Conclusions

Water planning in arid regions has two broad objectives: to guarantee water supply to economic uses (quantity, reliability, quality) and simultaneously the achievement of the Good Ecological Status that imposes a minimal environmental flow (enforced by Water Framework Directive (WFD) 2000/60/EC). This imposes constraints to the use of water for irrigation derived from climate variability, climate change and growing competition between water users, puts irrigation water allocation rules at the core of the challenges for water management and the provisioning of those services in European water scarce regions.

There are two general approaches when dealing with the quantities problems faced by irrigated agriculture. The traditional one is a supply-side approach, mainly based on increasing water supply by large-scale infrastructures; and the other one is the emerging approach based on demand-side initiatives that rely on measures as water pricing, revision of water rights and development of regulated water markets, among others. Their implementation requires careful application and a reliable information base. The literature has focused mostly in the relation between uncertainty over water supply guarantee and farmers' benefits existence, but they are almost exclusively restricted to market values. This study aims to fill this gap in the literature by assessing the value of the water supply guarantee improvement, because, although it has been studied extensively in the case of household and business use, the analysis for irrigation use has not been addressed in the literature before. This paper aims to contribute to the knowledge required in this complex process through the findings of evidences that could serve as pre-requisite for any type of flexible mechanism to work. For this purpose we investigate farmers' willingness to pay for the improvement of irrigation water supply guarantee using the contingent valuation method in a river basin in Southern Spain in which the uncertainty about water availability to irrigation is a severe problem every season, as happens in the most of arid and semiarid regions of the world.

The applied contingent valuation exercise shows that river basin farmers are concerned about water scarcity problems and the effects that these have for their production and that there is uncertainty about the available water to irrigation each season. Respondents derive a significant value from the increase of guaranteed water supply. They are willing to increase over 10% and 20% (50% and 90% of guarantee level respectively) their current irrigators community fee.

This result suggests that, when water is scarce, people not only have direct use values for the water guarantee, but also hold values associates with the improvement of this water attribute; farmers see the benefits in this change as their welfare increases, providing the evidence of the pre-requisite existence needed for any type of flexible mechanism to work. Furthermore, WTP values for the same allocation are lower than the little reservoir Balsa del Cadimo's estimated cost of investment (it would be charged to beneficiary farmers), it implies that the flexible measures could be more convenient for the farmers, as structural measures like this waterworks are not as legitimate as the other ones. It might be possible that the farmers would be reluctant to finance them.

The finding of heterogeneity of the demand shows that socioeconomic and production characteristics such as age, annual household gross income, agricultural training, household size and production characteristics like olive per hectare and perceived water quota influences the value of WTP. This additional information could help policy makers to better target their interventions for improving their knowledge about the likely support among different types of farmers for specific policy actions.

Future research could focus specifically on water supply guarantee valuation linked to Water Right Exchange Mechanism in order to assess the reception of this kind of measures by the farmers.

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