Factors affecting farmers' WTP for innovative fertilizer against soil salinity

by

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Abstract

Salt stress noxiously shocks agricultural yield all over the world affecting production either it is for subsistence or economic outcomes. However, the market for anti-salinity products is still developing and little is known about the willingness to pay for agricultural supplies, these have been largely focused on using stated preference methods only. This paper applied both Contingent and Inferred Valuation Method for the purpose of examining the determinants of farmers' willingness to pay for two packages of an innovative anti-salinity fertilizer, which does not yet exist in the market, in the regions of southwest Greece. With the aid of questionnaire, primary data were obtained from 150 farmers. Willingness to pay for the two packages of liquid fertilizer was measured through dichotomous choice. For the econometric analysis, interval regression model was used. The results revealed that farmers' willingness to pay for the specific anti-salinity product is influenced by a host of factors. Especially, the regression showed that the size of cultivated land, the level of education, the knowledge scale about salinity, the package of liquid fertilizer that farmers usually buy and the consequentiality script have a positive effect on willingness to pay, whilst hypothetical bias and inferred valuation method have a negative effect. Also, we examined a methodological issue concerning the order that the package of fertilizer was appeared in the willingness to pay question which has a positive effect on willingness to pay. The implication is that taking these factors into account while large companies are looking for new and profitable products by investing for research and development enables companies' managers to come up with projects that win acceptance from the farmers.

Keywords: salinity; willingness to pay; contingent valuation; inferred valuation; dichotomous choice

1. Introduction

Most of the plants are exposed to a lot of stresses throughout their life cycle. Abiotic stresses, such as salinity, drought, chemical toxicity, extreme temperatures and oxidative stress are major threats to agriculture, leading to the downgrading of the environment. Salinity is a serious restriction on agriculture and likely to increase its consequences in the future. Over the next decades continued population growth and rising living standards likely to demand an increase in agricultural products. Food and Agriculture Organization of the United Nations (FAO) estimates that there will be an additional 2 billion people by 2050 (FAO, 2013). Salinity is among one of the most challenging environmental constrains to crop productivity worldwide. Salt stress has a serious impact on agricultural yield all over the world affecting production whether it is for subsistence or economic outcomes. Huge terrains all over the world are shut down each year due to their extensive salinization, resulting in a decrease in their productivity. Almost, 7% and 20% of the world's land area and cultivated land respectively, and nearly half of the irrigated land is adversely affected by high salt contents (Zhu, 2001). In view of another projection, 2% of non-irrigated cultivated

soils (320 million acres[1] out of a total of 15000 million acres) and 20% of irrigated lands (450 million acres out of a total of 2300 million acres) are affected by secondary[2]salinity (FAO, 2005). Agricultural losses caused by salinity are difficult to estimate but supposed to be significant and expected to increase with time. More than 12 billion US $ per year losses in agricultural production systems are estimated and the cost is expected to increase as soils are further affected (Ghassemi et al., 1995).

In the preface to the 'Special Issue: Plants and Salinity', Tim Flowers (2006) pointed out that ''*Salinity has been a threat to agriculture in some parts of the world for over 3000 years; in recent times, the threat has grown*''. According to historical facts, between 4000 and 2000 BC the Sumerian people ruined their land and consequently their culture in the valleys of Tigris and Euphrates in Mesopotamia by their irrigation practices, which caused secondary salinization and first eradicated the production of wheat and subsequently barley which is one of the most salt-tolerant species. This led to the dissolution of the civilizations of Mesopotamia and the rise of Babylon (Potts, 1997). However, the salinity problem is considerable and continuing to grow. It is estimated that there are 76 million hectares (Mha) of human-induced salt affected land, representing 5% of the world's cultivated land (Ghassemi et al., 1995). Anthropogenic sources of soil salinization are the presence of salts in irrigation waters, residual salts from soil and water modifications, applied effluents and chemical fertilizers. The term ''salinity'' refers to the presence in soil (soil solution or technical solution) and water of dissolved salts in high concentrations that are detrimental to the soil. The composition of salts in large amounts mostly are calcium, sodium, magnesium, chloride and sulphate ions and in relatively small amounts are potassium, carbonates, bicarbonates, borate and lithium salts (Zhu, 2001). Approximately 17% of the world's cropland is under irrigation, but irrigated agriculture contributes much more than 30% of the total agricultural production (Hillel, 2000). Therefore, secondary salinization of irrigated lands is crucial for global food production.

Moreover, plant sensitivity to soil salinity changes during the growing season and varies with the physiological stage of crop development. Salt affects plants in different ways and on different complexity stages. Several reports are focused on comparing the response of salt - tolerance and salt - sensitive species. The most common effect on plants is a general stunting of growth as salinity reduces the ability of plants to take up water. High salt levels cause various effects on plant physiology such as ion toxicity, changes in plant growth, elementary nutrient deficiencies, decreased photosynthetic capacity, nutritional disorders, hyperosmotic stress and ion disequilibrium, leaf burn, necrosis and defoliation. These effects vary among species and especially among varieties of a given crop. For example, a high concentration in the soil may damage one species, but it doesn't necessarily have a harmful effect on another. Crops are classified in five groups depending on their sensitivity to salinity: sensitive, moderately sensitive, moderately tolerant, tolerant, unsuitable tolerant (Maas and Hoffman, 1977). In fact, is difficult to accurately determine the level of salt concentration in which the crops are more resistant, due to the fact that plant sensitivity depends on different and interacting factors such as climate (temperature and potential evaporation), soil fertility (availability of nutrients), soil physical conditions (porosity, aeration, water regime), genotype and plant age. In addition to the salinity resistance

[1] Acres: Area of land where 1 acre equals to approximately 0.40 hectare

[2] Secondary salinization of soils may be due to human induced practices and management in regard to irrigation (over irrigation, poor water quality) and drainage, high fertilizer input, grazing and deforestation.

mechanisms developed by the plant itself (salt inclusion, salt exclusion), several techniques have been developed in order to reduce the phenomenon. A plant's response to a given level of salinity cannot be determined in absolute terms and depends on the concentration and composition of the ions in solution. For instance, farmers have to know the ways in which plants respond to salinity, the relative tolerances of different crops and their sensitivity at different rates of growth. As a consequence, there is a high potential for ''anti-salinity'' products. Excellent resources for additional and more detailed information regarding salt tolerance of plants are the *Salinity: Environment – Plants – Molecules* (Läuchli and Lüttge, 2002) and *Mechanisms of Salinity Tolerance* (Munns and Tester, 2008).

In several studies, economists have provided significant evidence about agricultural technology adoption and diffusion among growers in developing countries. Rogers (2010), suggested that the level to which any innovation is supposed to be value-added compared with the existing product it is substituting is defined by relative advantage. Theoretical and empirical literature, suggest that producers choose to adopt a new technology in order to hedge against production risk (Koundouri et al., 2006). Farmers' decision to adopt a new technology depends partly on the way that they accept, process and evaluate information about innovations. Agricultural innovation may involve new and improved varieties of seeds, new types of fertilizer and pesticides for adoption which results in an increase in crop yields. According to Murphy (2012), ''*The adoption of new technologies and policies has been fundamental to agricultural development over the last 50 years*''. Sanginga et al. (2009) also note that ''*the wave of innovation is called the ''diffusion curve'' which is usually depicted as an S: The diffusion process starts slowly then gathers momentum and finally peters out when all farmers whom it is relevant or feasible have adopted the innovation*''. When a new technology begins to be adopted, three separate groups of farming population are observed: early adopters, followers and laggards (Cochrane, 1979). Firstly, only a few individuals adopt the innovation. Initially, a small number of the early adopters makes profit from the adoption of innovation. Then, followers (the large share of the farming group) seeing the early adopters' profits, tend to adopt the innovation during its take-off stage. Thus, this category of adopters may gain or lose from the innovation as a result of their choice that will finally tend to decrease prices and as well the profits. The laggards are the farmers who delay to adopt the innovation or do not adopt to all (they produce at low prices the same quantity as before). On the other hand, certain categories of producers who are too small, too old or too intransigent, are rarely able to keep up with new practices, so they drop out.

For a farmer (producer), is significant to maximize his/her profit-making decisions according to budget limitations, input and product combinations. In the same way, companies define their production according to their technological equipment, cost constraints and the inputs' plurality of combinations in order to produce outputs. Through willingness to pay (WTP) is possible to formulate the demand curve for a new entrant product in the marketplace. As a result, the average value will be seen as an estimation of the price that farmers could pay for a desired amount of fertilizer. The WTP is an estimation that of the company's demand and also compared to the present market prices offers significant information about the market situation. In fact, the ordinary Marshallian demand curve doesn't hold the level of utility or satisfaction constant but holds the income stable. On the other hand, Hicks proposed two valuation measures of the gain or loss that hold utility constant and refer to consumers who are able to vary the quantity of the under valuation good (Mitchell and Carson, 1989)

In this research study, an attempt has been made to examine producers' WTP for an innovative fertilizer against salinity and define the major factors affecting on the payment decision amongst Greek farmers. Nevertheless, information about producer acceptability and willingness to pay is not widely reported. A number of previous studies have analyzed adoption and farmers' willingness to pay for agricultural products and policies (Lichtenberg and Zimmerman 1999; Qaim and Janvry 2002; Danso et al. 2006; Bakopoulou et al. 2010; Uddin et al. 2016; Etim and Benson 2016; Bozorg-Haddad et al. 2016; Adnan et al. 2017). The key-words to search for these articles were based on words such as ''fertilizers'', ''producer's willingness to pay for fertilizers'', ''adoption of innovative fertilizers'' and ''salinity fertilizers''. To the best of our knowledge, farmers' preferences and willingness to pay for fertilizers against soil salinity have not been investigated. Furthermore, additional research into this area demonstrates a number of non-financial variables affecting the decision of farmers on the adoption of new technologies and policies, such as farmer and household characteristics (e.g., age, education, gender, stage in family cycle), type and size of the farm, grower's social milieu (e.g., local culture, social attitude, fellow farmers, policy environment) and the characteristics of the innovation to be adopted (Murphy, 2012). This research also works as an ancillary and advisory service to the industries of agricultural supplies concerning the pricing policy they have to apply to a new product that is not yet on the marketplace. Finally, it is a useful source of information for these industries about the farmers' acceptance of an innovative product.

2. A theoretical review

Since the objective of this study is to uncover producers' preferences and WTP for an innovative fertilizer against salinity, the method used for the above investigation is Contingent Valuation method (CV) which belongs to stated preference methods[3]. The CV method has become one of the most widely used methods to measure WTP values for private and public goods, services or amenities. In simple terms, CV is a survey-based technique regularly used for placing monetary values on environmental goods and services not bought and sold in the market place. Also, is simple and has great flexibility, as well as allowing estimation of a total economic value, rather than just components of that total value[4]. This is not possible with many of its alternatives non-valuation techniques, too.

This valuation technique has been in use for more than 35 years, and nowadays there are over 2000 papers and studies related to the topic (Carson et al., 1995). The CV method was initially proposed by Ciriacy-Wantrup (1947) only in a theoretical level. However, the first empirical CV survey started with Davis (1963) who tried to estimate the benefits of goose hunting through a survey among the goose hunters[5]. Its application in other areas in economics such as health economics (e.g., Johannesson et al., 1991; Johannesson et al., 1993; Liu et al., 2000), transportation safety (e.g., Persson et al., 2001) and cultural

[3] Techniques for measuring the WTP are categorized in those including revealed preferences (RP) and those including stated preferences (SP). The SP method asks directly individuals about their preferences. On the other hand, the RP method notices individuals' behavior in markets. The advantage of SP method is that estimates use and non-use values while the RP method estimates the use value of a product or service.

[4] http://www.ecosystemvaluation.org

[5] For more details see: Mitchell and Carson, 1989.

economics (e.g., Santagata and Signorello, 2000) was being increasingly developed. Except for these areas, it has made significant progress in the valuation of food safety and food products on the last decades (e.g., Gil et al., 2000). It is called ''contingent'' valuation, since as people are asked to state their WTP, depended on a specific hypothetical scenario and description of the environmental service.

It is common that CV method can be applied for goods which are and are not traded in regular marketplaces. In particular, a hypothetical valuation scenario is created in which respondents are asked to state their maximum WTP for the product under valuation. An important aspect on CV surveys is the choice of payment vehicle that is being selected for the valuation question. There are many different question modes that can be used such as: open-ended (OE), bidding games, payment card, choice experiments and single-bounded method. Nevertheless, CVM is subject to severe criticism as economists have raised several types of objections. A large number of studies have shown that results from the CV method may seriously be sensitive in social desirability bias (hereinafter SDB) (e.g., Phillips and Clancy, 1970, 1972). In fact, SDB is considered to be one of the most common sources of bias affecting the validity of experimental and survey research findings (Peltier and Wash, 1990; Paulhus, 1991) and refers to the tendency of participants to give social desirable responses instead of selecting responses that reflect their true feelings, placing the speaker in a favorable light (Grimm, 2010). Among the methods that have developed of coping with social desirability bias, the Inferred Valuation method (IV) addresses SDB by asking participants to state their views concerning the average consumers' valuation for a good (Drichoutis et al., 2014).

Lusk and Norwood (2009), noted that the IV method creates valuations that are less likely to suffer from biases such as SDB. Also, they found that responses based on IV method predicted consumers' actual shopping behavior much better than CV method did. The authors proved that when social desirability was appeared, the IV method generated less hypothetical bias. Moreover, they observed that goods with normative dimensions are more acceptable to SDB. Therefore, the IV method is more effective to fill the gap between the laboratory and field valuations (Drichoutis et al., 2014).

The Dichotomous Choice (DC) format (also known as take-it-or-leave-it, closed-ended or referendum) was initially used by Bishop and Heberlein (1979), while Hanemann (1984) developed the conceptual and theoretical arguments in order to use this method to estimate welfare benefits (Ryan et al., 2004). Since the panel of National Oceanographic and Atmospheric Administration (NOOA) criticized the open-ended method as causing unstable and biased answers (Arrow et al., 1993), the DC approach gained remarkable acceptance due to its substantial simplicity of use in data collection and Incentive Compatibility (IC). Strategies that used by respondents have long been seen as a problem in public economics. In particular, Samuelson (1954) argued ''*It is in the selfish interest of each person to give false signals, to pretend to have less interest in a given collective activity than he really has*''. Incentive Compatibility can only be proposed for goods in cases that the binary choice is between two different forms of the under valuation good. Thus, such these choice designs led to a valuation question that presents a change in the good (Carson and Groves, 2007). Also, any response format that has at least three possible outcomes is subject to individual manipulation (Drichoutis et al., 2014).

There is strong evidence which proves that CV technique frequently overstates real economic value. Much of the literature compares hypothetical and actual values from

several CV studies. Hypothetical bias refers to a significant difference between response to real and hypothetical valuation questions. This situation has motivated research in order to develop methods that whether eliminate or adjust hypothetical bias. The ''cheap talk method'' was initially recommended by Cummings and Taylor (1999). They made an attempt to decrease the hypothetical bias by completely describing and discussing the tendency of participants to exaggerate stated WTP. The use of cheap talk proved to be potentially effective as well as decreasing the mean WTP in several studies (e.g., Cummings and Taylor, 1999; List, 2001; List et al., 2006; Aadland and Caplan, 2003; Bulte et al. 2005; Landry and List, 2007). Its simplicity makes it an attractive approach in lowering hypothetical bias (Murphy et al., 2005). Nevertheless, in other studies it has not been effective (e.g., Brummett et al., 2007; Loureiro et al., 2009). Furthermore, the hypothetical WTP with cheap talk script could not be proved to be statistically significantly dissimilar from the real WTP (Carlsson et al., 2005). Empirical findings revealed that participants in CV surveys give answers which are inconsistent with the tenets of rational choice as well as they might underestimate or overestimate their paying ability for a variety of reasons (e.g. the surveys' results are not binding). Carson and Groves (2007) argued that a hypothetical survey might bring in more than hypothetical responses in case that the survey is perceived by respondents to be consequential. In consequentiality scripts, survey participants are clearly told that their responses to preference questions will influence competent authorities' decisions regarding the public good under valuation. Therefore, the respondents' answers represent a revealed economic behavior. In their study, Vossler and Watson (2013) showed that the participants who believed that results of the survey would not be considered by policy makers were less expected to vote a desired program. In a CV study of a private good with and without a fair labor label, Drichoutis et al. (2014) found that their consequentiality and cheap talk script had not any effect in mitigating hypothetical bias. External validation of the CV technique continues to be a serious issue. One way to avoid these difficulties, in part, is to design experiments in which an artificial capability is created to pay for private or public goods. So, it is recommended the results of a CV estimation of WTP could be compared with the ''real'' behavioral WTP for goods (in a sample or an analogous sample) that can really be bought and sold (Arrow et al., 1993).

3. Survey design

The design of the questionnaire is a key issue in a survey as the answers received depend on the information provided. The researcher should also asses the amount of information required, particularly when the product under valuation is similar to other products already available on the market and whose properties are known by consumers. The main problem of estimating the demand for a highly innovative commercial product, including a number that have not already been produced, as the under-valuation product in this research, is similar to the problem faced in CV research which concerns the valuation of WTP for a necessarily unknown product (Arrow et al., 1993).

The action of the under-valuation product is focused on treating the symptoms of salinity. Its application is mainly proposed in crops with particular sensitivity to the presence of salts. To elicit valuations for the fertilizer against salinity, we examined two packs of 1lt and 5lt capacity respectively. Also, we ought to say that the prices for the under valuation good have not yet been established, as salinity products are in the final experimental stage. Therefore, some indicative prices for each package were given by the competent company

based on prices of other similar products. There were ten bid amounts used for the Discrete Choice format. The amounts used to each package were:

- **1lt**: 10 euro vs. 12 euro vs. 15 euro vs. 17 euro vs. 20 euro (€)
- **5lt**: 37 euro vs. 45 euro vs. 56 euro vs. 63 euro vs. 75 euro (€)

In each questionnaire was examined the WTP for both packages of fertilizer. Respondents, were randomly assigned one of ten different prices for each package. Especially, half of the participants were asked to answer the WTP question for the 1lt package first and then for the 5lt package. Conversely, the rest of the sample had to answer the WTP question for the 5lt package first and then for the 1lt package. Table 1 summarizes the survey's experimental design.

Table 1: Survey's experimental design

Packages **1lt – 5 lt** **5 lt – 1lt**				
a. 10 – 37	b. 12 - 37	c. 15 - 37	d. 17 - 37	e. 20 - 37
10 – 45	12 - 45	15 - 45	17 - 45	20 - 45
10 – 56	12 - 56	15 - 56	17 - 56	20 - 56
10 – 63	12 - 63	15 - 63	17 - 63	20 - 63
10 - 75	12 - 75	15 - 75	17 - 75	20 - 75

The questionnaire used for the study consists of seven parts and below follows a brief explanation of those.

Part 1. Salinity knowledge

This part includes ten ''True / False'' sentences related to salinity issues. The higher the number of correct answers, the higher the knowledge that producers have of the problems associated with soil salinity.

Part 2. Willingness to pay

At first producers were detail informed about the product and its characteristics (type of innovation, mode of action, application recommendation, benefits for the crops and the producers, comparative advantages). This information is very important as we have to do with a new product on the Greek market for agricultural supplies, whose potential and advantages are unknown to the producers. Due to this reason, the information provided must be both scientifically valid and understandable by an average producer who is likely to know little or nothing about the under valuation good.

Then, the cheap talk script was compiled from several studies (e.g., Drichoutis et al. 2014; Bulte et al., 2005) reads as follows:

''In a minute you will be asked whether you are willing to pay a certain amount for the specific fertilizer.

This question will be hypothetical, that is, you will not actually have to pay. In general, people experience difficulties in answering hypothetical questions. They often state they are willing to pay an amount larger than the amount they are willing to pay in reality.

One reason why this happens is because when the time comes to actually make the payment, they also consider that this money won't be available for other purchases. Therefore, when the question is hypothetical, their response exaggerates.

Before answering the willingness to pay question, try to think whether you are really willing to pay this amount for the fertilizer and that this amount will no longer be available for other purchases.''

The consequentiality script was adopted by Vossler and Watson (2013) and Vossler and Evans (2009) and read as follows:

''We would like to inform you that the survey results will become available to producers, traders and retailers of agricultural supplies as well as to the wider general public of consumers. This means that this survey could affect the decision of producers, traders and retailers to adopt practices for the production of innovative agricultural products and as a result of the average price of the fertilizer.''

After the above scripts were read, the valuation questions followed. We used a dichotomous choice question as recommended by the NOOA (Arrow et al., 1993). Farmers were asked to the following yes/no questions:

WTP for packaging of 1lt:

''Would you be willing to pay ___€ (including VAT) to buy 1lt bottle of the specific liquid fertilizer?''

WTP for packaging of 5lt:

''Would you be willing to pay ___€ (including VAT) to buy 5lt of the specific liquid fertilizer?''

According to the literature on certainty scales (Champ et al., 1997), every CV discrete choice question was followed by a question asking the participants to state how certain they were about their answer on a 10-point scale characterized by the labels ''Not certain at all'' and ''Very certain''.

Similar to CV questions to the questions, the IV questions were formatted to elicit the WTP for each package of the fertilizer.

''Do you think that an average producer would be willing to pay ___€ (including VAT) to buy 1lt bottle of the specific liquid fertilizer?''

'' Do you think that an average producer would be willing to pay ___€ (including VAT) to buy 5lt bottle of the specific liquid fertilizer?''

A consequentiality question (Vossler et al., 2012; Vossler and Watson 2013) was also followed to help us to test for differences between participants with different consequentiality perceptions of the survey. Respondents had to point out the indirect consequences of the survey on a 5-point Likert scale characterized by the labels ''not at all'' and ''very much''. The question read as follows:

''To what extend do you believe that your answers in this survey will be taken into account by producers, traders and retailers?''

Subsequently, using the social desirability scale of Stöber (2001) the questionnaire elicited participants' beliefs about the probability of social desirability bias and hypothetical bias.

Part 3. Farm characteristics

This part includes questions in which farmers provide information related to the type of crop. They were then asked about the size (in acres) of the farm.

Part 4. Sources of information

A question was also included to allow us to clarify the farmers' level of information from specific sources related to agricultural issues. For this reason, participants had to state their response on a 5-point Likert scale anchored with the labels ''absolutely disagree'' and ''totally agree''.

Part 5. Farmers' buying behavior

This section includes the sum total of a farmer's attitudes, preferences, intentions and decisions regarding their behavior in the marketplace when purchasing a product or a service. At first, participants were asked to indicate the place from which they buy their fertilizers. Also, they had to state certain factors that influence their decision to purchase a fertilizer. The answers were on a 5-graded Likert scale from 1-5 where 1 was ''no significant'' and 5 was ''very significant''. This part concludes with two additional questions concerning the capacity of the liquid fertilizer package that farmers usually buy.

Part 6. Salinity problem background

The sixth part is mainly concentrating on farmers' salinity problem. In particular, these questions attempted to explain whether participants have faced or face salinity problems in their crops, if they have used any product to deal with it and their satisfaction with the particular product.

Part 7. Farmer demographics

The last section concerns basic information about the respondents. Examples are age, gender, education, farm experience, primary and secondary employment perceived income of the household and a question about farmers' adoption of a ''new method'' to their cultivation technique and note this ''new method''.

However, a number of the questions were experienced as uncomfortable or sensitive by the participants. The most sensitive concerned income as there is a risk that farmers might have stated a lower income in hope that the research will cause a price change that will affect them positively. In general sensitive questions may influence the participants' attitude concerning the study.

4. Data collection methods

Questionnaires are preferably personally carried out, since this lead to higher response rates with a better quality than other methods (Arrow et al., 1993). They are also more flexible and reliable, despite their high cost, as personal contact is able to minimize problems with the interpretation of some questions, since the researchers have the opportunity to ensure that participants understand it correctly.

A pilot questionnaire was pre-tested in Messinian regions in a small sample of subjects. Through this process some ''strengths and weaknesses'' could be estimated in the structure of the questionnaire. Furthermore, it was helpful for us to know where problems might arise during the interview. Thus, it was found that some of the existing questions needed redesign in order to be clearer and some other removed. The full scale survey was then launched on May 14, 2017 and questionnaires were filled in until August 21, 2017.

The study was conducted in locations of Messenia, Argolida and Corinthia. Locations were selected after an evaluation of their availability and the type of cropping that is used there. The main categories of crops selected were those of vegetables (tomatoes, potatoes,

cucumbers, lettuce), citrus fruit (orange, lemon, mandarin), peaches, apricots, almonds, cherries, vines and pomegranates that are more sensitive to salinity. Also, most of the chosen areas face salinity problems due to reasons that have been referred above. The meetings with the farmers were held by phone appointment. The farmers' phone numbers were available through lists provided by public agricultural services and agronomic shops. During the telephone conversation with the farmers, we introduced ourselves and the aim of this study, before asking them if they were willing to participate. The personal interviews took place in their farms. In all, the 189 subjects that were asked to participate in the survey and 150 agreed to take part resulting in a cooperation rate of 79.36%. The questionnaire took participants around 15 minutes to complete. Nevertheless, a small number of the participants refused to respond to certain questions which further reduced the available sample for statistical analysis. Data were subjected to analysis using the software STATA v.14.0.

Table 2: Summary of descriptive statistics

Definition of Variables (Variables)	**Variable levels**	**Frequency**	**Mean**
Age (age)			48.94
Farm experience (years)			25.77
Gender (gender)	Male	141	94.00%
	Female	9	6.00%
Education (edu)	Up to primary school	11	7.33%
	Primary school	36	24.00%
	Secondary school	73	48.67%
	College graduate	11	7.33%
	University graduate	19	12.67%
Income (income)	Very bad	2	1.33%
	Bad	7	4.67%
	Below average	19	12.67%
	Average	58	38.67%
	Above average	30	20.00%
	Good	26	17.33%
	Very good	8	5.33%
Application of a ''new method'' (innov)	Yes	38	25.33%
	No	112	74.67%
Salinity problem (salpr)	Yes	86	57.33%
	No	26	25.33%
	I don't know	38	17.33%
Product against salinity (proion)	Yes	90	72.58%
	No	34	27.42%
Satisfaction (satisf)	Very little	1	2.95%
	Little	12	35.30%
	Medium	13	38.23%
	Very	4	11.76%
	Very much	4	11.76%
Package of fertilizer that farmers usually buy (susk)	Unpacked	0	0.00%
	1 lt	22	14.67%

	2,5 lt	8	5.33%
	5 lt	31	20.67%
	Do not buy liquid fertilizer	39	26.00%
	Package > 10 lt	50	33.33%

5. Descriptive data analysis

Before the presentation of the econometric analysis we are able to find interesting information by looking at the raw data (see Table 2). The ages of the subjects ranged between 23 and 92 years and averaged 49 years. The vast majority of respondents were males (94%) whiles females were 6 %. This might have been so because in Greek reality, and not only, agriculture is typically a ''male'' job and hence, the proportion of men was expected to be much higher than that of women. Also, farmers' educational level was measured at five levels: up to primary school, primary school, secondary school, college graduate, university graduate. Other variables measured were farmers' experience in agriculture, the household income, the application of a new method. According to the educational background, the results revealed that most farmers (48.67%) had secondary school education. This is an indication that since most farmers were literate, it was more likely to have a higher receptiveness to new products. The vast majority of the sample (74.67%) stated that does not apply a ''new method'' in their cultivation technique. Furthermore, 57.33% claimed that faces salinity problems in his crops. From those whose crops suffer from salinization about 72.58% have used a product to face this problem and the majority was ''Little/Medium'' satisfied from its effectiveness. Finally, the 33.33% of the sample usually buys packages of liquid fertilizer with a capacity of more than 10 lt. This implies that the producers prefer mainly the larger packages.

Table 3 below revealed that 33.33% of the farmers affirmed that ''price'' is ''Very important'' factor for their choice of fertilizer. This was followed by 68.67% and 30.67% of the participants who stated that the ''quality-composition'' and the existence of ''innovation-patent'', respectively, are ''Very important'' reasons for choosing a fertilizer. It is worthwhile the fact that 37.33% of farmers claimed that ''packaging quality characteristics'' is ''Not important at all'' reason for their choice of fertilizer. Furthermore, 24% agreed that ''brand name'' is ''Important'' for their decision to buy a fertilizer. Finally, the majority of the respondents (about 79.33%) said that ''rapid action'' is ''Very important'' factor behind their choice of fertilizer.

Table 3: Factors responsible for farmer's choice of fertilizer

	Not important at all				**Very important**
Price	8(5.33%)	27(18.00%)	21(14.00%)	44(29.33%)	50(33.33%)
Quality-composition	1(0.67%)	0.00%	9(6.00%)	37(24.67%)	103(68.67%)
Packaging quality characteristics	56(37.33%)	37(24.67%)	30(20.00%)	13(8.67%)	14(9.33%)
Brand name	31(20.67%)	20(13.33%)	36(24.00%)	28(18.67%)	35(23.33%)
Ease of application	17(11.33%)	26(17.33%)	33(22.00%)	36(24.00%)	38(25.33%)
Rapid action	0.00%	0.00%	2(1.33%)	29(19.33%)	119(79.33%)

Innovation-Patent	18(12%)	17(11.33%)	26(17.33%)	43(28.67%)	46(30.67%)

Note: Figures in brackets represent percentages, while others are frequencies

Concerning the farmers' WTP for the package of 1lt (Figure 1), it seems that as the proposed bids increase the percentage of farmers WTP for the good is reduced. Also, WTP based on IV method is lower than CV method. The same trend is observed for the 5lt package.

According to CV method, the vast majority of the sample (86.7%) is willing to pay the amount of 12 € for the 1lt package and about 73.3% is willing to pay 10 € for the 5lt package with the IV method.

As we can see from the Figure 1 about 93.3% of the farmers would offer the amount of 37 € for the 5lt package and finally with the IV method the majority of the respondents would also pay 37 € for the 5lt package.

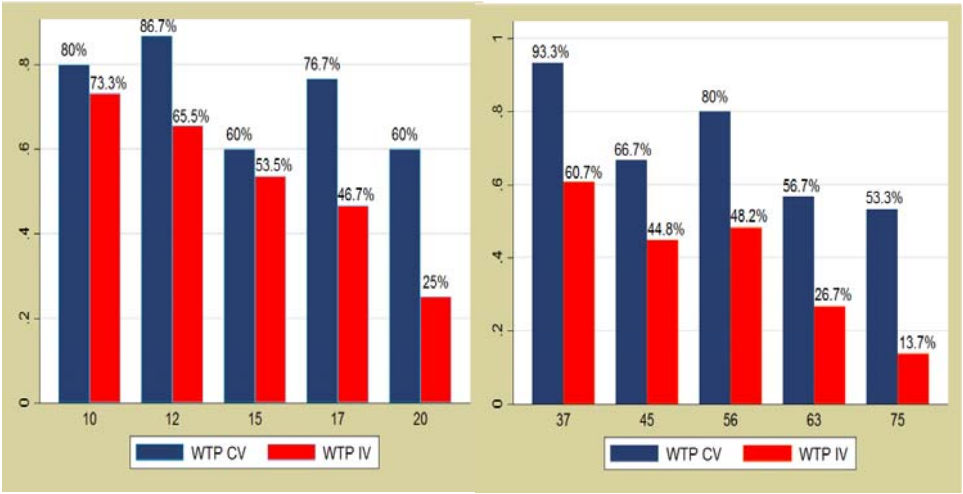

Figure 1: % of WTP for the 1lt package (left) and 5lt package (right) with CV and IV methods

Explanatory variables considered in the econometric model are defined in Table 4 (APPENDIX A). Observations with missing variables were left out from the econometric analysis. Accordingly, the sample for the WTP model consists in 145 subjects.

7. Empirical Results

For the econometric valuation, the Interval Regression Model was used. As a dependent variable we define the interval or declared WTP, as derived from the single binary method. According to the above, the econometric model takes the following form:

WTP = $b_0 + b_1 CVIV_2 + b_2 order + b_3 conseq_3 + b_4 conseq_4 + b_5 hbias_2 + b_6 hbias_3 + b_7 hbiasot_3 + b_8 hbiasot_4 + b_9 sunesp + b_{10} sunpur + b_{11} kt + b_{12} ku + b_{13} sunloi + b_{14} sunel + b_{15} know\_new_3 + b_{16} know\_new_4 + b_{17} know\_new_5 + b_{18} age_2 + b_{19} age_3 + b_{20} years + b_{21} edu_2 + b_{22} edu_3 + b_{23} edu_4 + b_{24} income_4 + b_{25} income_5 + b_{26} income_6 + b_{27} susk_3 + b_{28} susk_4 + b_{29} susk_5 + b_{30} susk_6 + b_{31} innov + b_{32} salpr_2 + b_{33} salpr_3 + u + b_{34} bottle$

The estimation results are shown in Table 5. It was supposed that WTP for the fertilizer against salinity would be affected by the variables: ***age***, ***income***, ***salpr***, ***edu***, ***years*** and ***know_new***. Especially, it was expected that:

- Younger farmers are more acceptable to agricultural innovations and new products than older ones.
- An increase in farmers' income could enhance their WTP for the fertilizer.
- Farmers with experience in salinity problems would be able to pay more than others with no experience.
- Farmers with a higher level of education would better understand the benefits of the innovative fertilizer and pay for it.
- Farmers with more years of experience have accumulated years of observation and experimentation with many and different agricultural technologies would be more likely to pay more and faster than the others with less experience in farming.
- In general, it was presumed that farmers with a higher score in the knowledge of soil salinization would be willing to pay more than the others with a lower score.

In this study, we observe that the variable ***CVIV*** associated with the method of willingness to pay has a coefficient of -4.332 and is negatively significant (at 5% significant level). This implies that the average difference between the CV and IV methods for both packages is 4.33 €/lt. In particular, the farmers' willingness to pay per lt of packaging is 4.33 € lower with the IV method than the CV method. This indicate that subjects under the IV method are stating lower valuations, which is likely clue that this method successfully mitigates social desirability and hypothetical bias (See Part 2). Also, there is evidence of significant that ***order*** effects indicating that when the 1lt package of fertilizer was asked first, farmers tended to pay 3.86 €/lt more than the others who were first asked for the 5lt package of fertilizer. This could be due to the fact that answering the 1lt package question first, made the subjects think that it would be better for them to begin testing the product on a smaller field of crops in order to control its effectiveness.

As it referred in previous sections, recent literature has maintained that consequentiality (**conseq**) is necessary for incentive compatibility. In particular farmers who stated that they believed their answers will be taken into account by producers, traders and perceptions on a ''Moderate'' and ''Very/Very much'' likelihood were willing to pay 3.86 €/lt more than the others who believed that their responses will be taken ''Not at all/Low'' into account. Also, participants who noted that is ''Likely/Very likely'' for their colleagues to exaggerate in their answers (**hbiasot**) were willing to pay 5.72 €/lt less, compared to those who stated ''Not likely at all/Unlikely''.

The study revealed that increasing the size of cultivated land is likely to increase farmers' willingness to pay. It seems that the variables ***kt*** and ***sunloi*** have a positive effect on our dependent variable. That is, for every extra acre of greenhouse crops (kt) and the crops of vine and pomegranate (sunloi) were willing to pay 12 cents/lt and 19 cents/lt more respectively. Regarding the level of education, as we hypothesized above, farmers who have acquired a ''Secondary school'' education and the ''University/College graduate'' had a higher willingness to pay compared to those who declared a ''Up to primary school'' level of 5.85 €/lt and 6.16 €/lt more respectively. This element supports the hypothesis that human capital plays a positive role in the adoption and evaluation of new ideas (Etim and Edet, 2013; Etim and Benson, 2016).

Another determinant factor is the knowledge scale about salinity. The results of the econometric analysis indicated that there is a positive correlation between the variable ***know_new*** and the willingness to pay, since farmers who have ''Very good'' knowledge were willing to pay 4.82 €/lt more than those who have ''Minimum/Low'' knowledge. Finally, variable ***susk***, in which each producer indicated the package of liquid fertilizer that usually buys, has a positive effect on willingness to pay. Farmers that usually buy liquid fertilizer in 2,5 lt package were willing to pay 13.2 €/lt more than the others who buy the 1 lt package. It is worthwhile that the variables ***age***, ***income***, ***years*** and ***salpr*** hadn't any effect on the farmers' willingness to pay.

Table 5: Choice experiment estimation

Variables	Coef. (SE)	Variables	Coef. (SE)
$CVIV_2$*	-4.332*	$know\_new_5$	0.747
	(1.099)		(2.329)
order*	3.867*	age_2	-1.449
	(1.166)		(1.696)
$bottle_5$*	9.947*	age_3	-2.661
	(2.069)		(2.859)
$conseq_3$*	3.861*	years	0.076
	(1.405)		(0.056)
$conseq_4$*	3.864*	edu_2	3.511
	(1.537)		(2.682)
$hbias_2$	1.514	edu_3*	5.852*
	(1.503)		(2.809)
$hbias_3$	3.260**	edu_4*	6.166*
	(1.904)		(3.065)
$hbiasot_3$	-2.725**	$income_4$	-1.068
	(1.491)		(1.722)
$hbiasot_4$*	-5.727*	$income_5$	-2.549
	(1.499)		(1.870)
sunesp	-0.028	$income_6$	-1.675
	(0.048)		(1.896)
sunpur	-0.074	$susk_3$*	13.200*
	(0.061)		(4.382)
kt*	0.128*	$susk_4$	-0.988
	(0.059)		(1.849)
ku	-0.014	$susk_5$	-0.441
	(0.011)		(1.904)
sunloi*	0.195*	$susk_6$	-0.783
	(0.086)		(1.798)
sunel	-0.018	innov	-2.102
	(0.016)		(1.411)
$know\_new_3$	2.103	$salpr_2$	-1.958
	(1.858)		(1.945)
$know\_new_4$*	4.822*	$salpr_3$	0.023
	(1.914)		(1.426)

Notes: * and ** represent significance at the 5% and 10%, respectively.

We can then proceed in graphing the aggregate demand curve for the innovative fertilizer against salinity. Figure 2 does exactly that for valuations elicited with both CV and IV

(common regression CV-IV). The extraction of the demand curve is based on the acceptance that we refer to buying a unit per product per consumer. Each point of this curve indicates the percentage of respondents that would buy of fertilizer at the bids projected on the Y axis. According to the results, the expected willingness to pay ranges from 2.55 € to 51.87 €. As we clearly see in Figure 2, the average willingness to pay for the under-valuation product is 22.91 €. Also, the average value for each liquid fertilizer package is 17.94 € for the 1lt and 139.4 € (27.88 €/lt) for the 5lt.

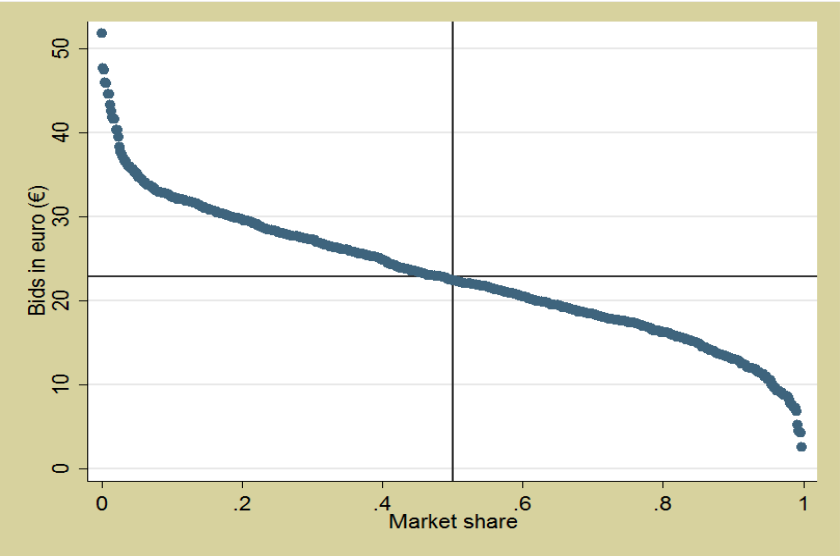

Figure 2: Demand curve from the common regression of the CV and IV elicitation methods

8. Conclusions and discussion

Salt accumulation in the soil and the economic damage resulting from this are some of the most serious problems facing agriculture. Salinity threatens the viability of agriculture as each year more land becomes nonproductive and millions of hectares of land throughout the world are too saline to produce economic crop yields. Unfortunately, large areas in the world as well as Greece remain untapped due to salinization. Fertilizer is one of the most crucial contributions that is being used to improve agricultural productivity. This paper sought to elicit farmers' willingness to pay for a new product in agricultural field. To do so, we used a Contingent Valuation method to uncover the underlying preferences of Greek farmers for two packages (1lt and 5lt) of an innovative fertilizer against salinity.

The survey result revealed that 57.33% claimed that face salinity problems in their crops and the vast majority of these farmers (72.58%) have used a product to tackle this problem without great success regarding the effectiveness of the product. On average, farmers would be willing to pay 22.91 €/lt for an innovative fertilizer against salinity. They willing to pay on average 17.94 € for the package of 1 lt and 27,88 € for the package of 5 lt. A possible explanation for this awkward result is that the under-valuation product that is examined in this study doesn't exist in real market hence, it is possible that there are systematic differences between farmers' estimation of hypothetical product alternatives and the real options.

Also, the econometric analysis indicates that the most critical determinants which had a positive effect on farmers' willingness to pay for the fertilizer were the level of education),

the farm size and the scale of knowledge about salinity. It also emerges that the liquid fertilizer package usually purchased by farmers and the farmers' perception of the extent in which they believe will influence with their responses are influenced positively farmers' willingness to pay. In contrast, a negative effect on willingness to pay was farmers' perception of the extent in which they believe that the other respondents in the survey will overtake their responses. The findings of this research are encouraging for the industries of agricultural supplies that make an effort to differentiate their products and are wondering if costs associated with product differentiation can be recouped from potential customers.

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APPENDIX A

Table 4: Presentation of dummies

Dummies	Definition of dummies
CVIV*	Contingent Valuation=1, 0 otherwise
$CVIV_2$	Inferred Valuation=1, 0 otherwise
order	The order of the package in the WTP question, where 0=5lt is the display of 5lt first and where 1=1lt is the display of 1lt first
$bottle_1$*	Package of 1lt=1, or 0
$bottle_5$	Package of 5lt=1,or 0
$conseq_2$*	1 if producer believes that his answers will be taken ''Not at all/Low'' into account, 0 otherwise
$conseq_3$	1 if producer believes that his answers will be taken ''Moderate'' into account, 0 otherwise
$conseq_4$	1 if producer believes that his answers will be taken ''Very/Very much'' into account, 0 otherwise
$hbias_1$*	1 if producer believes that it is ''Not likely at all'' to exaggerate his answers, 0 otherwise
$hbias_2$	1 if producer believes that it is ''Unlikely'' to exaggerate his answers, 0 otherwise
$hbias_3$	1 if producer believes that it is ''Neither likely, nor unlikely/Likely/Very likely'' to exaggerate his answers,0 otherwise
$hbiasot_2$*	1 if producer believes that it is ''Not likely at all/Unlikely'' for the other participants to exaggerate their answers, 0 otherwise
$hbiasot_3$	1 if producer believes that it is ''Neither likely, nor unlikely'' for the other participants to exaggerate their answers, 0 otherwise
$hbiasot_4$	1 if producer believes that it is ''Likely/Very likely'' for the other participants to exaggerate their answers, 0 otherwise
$know\_new_2$*	1 if producer has scored ''Minimum/Low'' knowledge, 0 otherwise
$know\_new_3$	1 if producer has scored ''Good'' knowledge, 0 otherwise
$know\_new_4$	1 if producer has scored ''Very good'' knowledge, 0 otherwise
$know\_new_5$	1 if producer has scored ''Excellent'' knowledge, 0 otherwise
age_1*	1 if age category < 40 years, 0 otherwise
age_2	1 if age category 41 – 60 years, 0 otherwise
age_3	1 if age category >60 years=1, 0 otherwise
edu_1*	1 if education level ''Up to primary school'', 0 otherwise
edu_2	1 if education level ''Primary school'', 0 otherwise
edu_3	1 if education level ''Secondary school'', 0 otherwise
edu_4	1 if education level ''University/College graduate'', 0 otherwise
$income_3$*	1 if income characterized ''Very bad/Bad/Below average'', 0 otherwise
$income_4$	1 if income characterized ''Average'', 0 otherwise
$income_5$	1 if income characterized ''Above average'', 0 otherwise
$income_6$	1 if income characterized ''Good/Very good'', 0 otherwise
$susk_1$	Purchase of bulk package=1, or 0
$susk_2$*	Package purchase of 1lt=1, or 0
$susk_3$	Package purchase of 2,5lt=1, or 0
$susk_4$	Package purchase of 5lt=1, or 0
$susk_5$	1 if producers do not buy liquid fertilizer, 0 otherwise
$susk_6$	1 if Package purchase >10lt, 0 otherwise
innov	Are you applying a new method to your cultivation technique?, where 1=Yes and 0=No
$Salpr_1$*	1 if farmer faces with salinity problems in his crops, 0 otherwise

$Salpr_2$	1 if farmer doesn't face with salinity problems in his crops, 0 otherwise
$Salpr_3$	1 if farmer doesn't know if his crops suffer from salinity, 0 otherwise

Notes: Variables with an * were not included in the econometric model in order to avoid the problem of Perfect Multicollinearity.
The dummy ***susk1*** was not included to the econometric model, as it had zero observations.