Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria (INIA)
http://dx.doi.org/10.5424/sjar/2014124-6061

Spanish Journal of Agricultural Research 2014 12(4): 889-901
ISSN: 1695-971X
eISSN: 2171-9292

RESEARCH ARTICLE

OPEN ACCESS

Evaluating the functionality of agricultural systems: social preferences for multifunctional peri-urban agriculture. The "Huerta de Valencia" as case study

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Abstract

The debate on the multifunctionality of agriculture and its connections with territorial policies are the basis of the most appropriate approach to legitimize public interventions in the agricultural sector. The main obstacle of this public intervention is to know the goods and services provided by agricultural systems and elicitation of the social preferences for them. We created a descriptive approach for the multifunctionality of agricultural systems that is based on the review of the scientific literature focused on multifunctionality and the goods and services of agricultural systems. The review shows a large variety of activities and approaches, which can be grouped by their economic dimension, social dimension and environmental dimension. Multicriteria techniques, such as the Analytic Hierarchy Process (AHP), can help elicit the priorities and the relative importance of different functions attributed by the society as a whole. The authorities can take into account these results to inform and support their political decisions. This paper describes a methodological approach to determine the Social Welfare Function by using AHP. The proposed methodology is applied to the "Huerta de Valencia", a rich peri-urban agricultural system with a variety of resources, around which there is an open political-institutional debate to define a protection scheme. The results are very interesting and useful to enrich this debate.

Additional key words: public goods; ecosystem services; social optimum; Analytic Hierarchy Process; priorities; consistency; social utility function; eigenvector.

Introduction

Some agricultural systems on the urban fringe are characterized as highly valuable agricultural ecosystems. They do not only perform important functions, but also provide goods and services valued by consumers and society. These goods and services are related to leisure and recreation, healthy and safe food production, the conservation of natural and cultural heritage, environmental conservation, etc.

This process is an opportunity to restructure farming beyond the traditional production model based on pure commodity production, and to change it into a new production system which provides consumers with other goods and services.

Other goods and services result from the joint-production function. The majority is non commodity ecosystem services with no established markets in which farmers can exchange them for income. The ecosystem services provided by agricultural activity differ from one agricultural system to another, and social welfare functions between countries and regions may also differ. Market failures can justify policy and planning instruments to help preserve some agricultural systems.

An analysis of the agricultural functional system is necessary to achieve efficient policy designs. Such an

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Received: 11-04-14. Accepted: 18-09-14.

This work has one supplementary figure that does not appear in the printed article but that accompanies the paper online.

Abbreviations used: AHP (Analytic Hierarchy Process); AIP (Method to Aggregate Individual Priorities); CI (Consistency Index); EM (Eigenvector Method); NCGS (non-commodity goods and services); RGMM (Row Geometric Mean Method); SUF (Social Utility Function); SWF (Social Welfare Function); VSI (Valencian Statistics Institute).

analysis is vital to learn about the functions and non-commodity ecosystem services provided by agriculture. In this line the multifunctional agriculture concept is a theoretical framework employed to characterize agricultural systems. The scientific literature published in recent years provides a comprehensive overview and analysis of existing discussion about the multifunctionality concept, as well as the supply of, and demand for the goods and services and functions attributed to agricultural systems. However, this analysis does not represent a compact set and well-defined contributions in order to identify agriculture-related objectives and functions clearly, beyond the environmental, social and economic functions established by the European Commission (Moreno, 2009).

To accomplish an optimal policy design another problem to deal with is to determine the consumer demand for these goods and services. It is very important to elicit the general public's preferences for goods and services in order to legitimise policy choices and to promote agricultural system functions that can maximise the welfare function.

In recent years an assortment of researches has applied the Analytic Hierarchy Process (AHP) technique to determine public preferences for functions and non-commodity ecosystem services. AHP applications are more common in environmental studies, as can be seen in a recent review by Huang *et al*. (2011). This method has been used in forest management (Ríos *et al*., 1998; Nordström *et al.*, 2010; Maroto *et al*., 2013), urban planning (Solnés, 2003; Gómez-Navarro *et al*., 2009; Zhang & Peng, 2011), environmental impact assessment (Ramanathan, 2001), hydrological management (Mesa *et al*., 2008), exploiting wetlands commercially (de Blaeij *et al.*, 2009), and to valuate goods and environmental services (Aznar & Estruch, 2007). AHP has also been used in agricultural studies to determine social preferences of rural areas (Duke & Aull-Hyde, 2002), to examine social preferences for agriculture irrigation areas (Gómez-Limón, 2006), to study social preferences for alternative olive systems in Spain (Parra-López *et al.*, 2008), or in Scotland to study the social acceptability of marine aquaculture, specifically in salmon farming (Whitmarsh & Palmieri, 2009).

Although the AHP technique has not been applied to many stakeholders in some revised research articles, such as 20 experts in studying alternative olive systems (Parra-López *et al.,* 2008), 11 in the Alto Tajo study (Aznar & Estruch, 2007), and 50 in hydrological management (Mesa *et al.,* 2008), many other studies have used a large number of respondents to determine social preferences.

This paper presents an AHP-based approach to study social preferences for the functions that the agriculture system should provide. It describes the methodology to define the problem structure by designing a coherent hierarchy. It also collects valuable judgments through appropriately designed questionnaires, systematic prioritization and aggregation of social preferences to determine the Social Welfare Function (SWF), which is relevant for adopting policies for the conservation and preservation of agricultural systems. The proposed methodology has been applied to the "Huerta de Valencia", a rich agricultural system with a variety of resources, around which there is an ongoing political-institutional debate to define a protection scheme.

Methodology

In Spain many papers about agricultural systems have been published taking into account their multifunctionality, but the literature does not deal with conceptual issues. In general the articles include the three generic dimensions (economic, environmental and social) with different objectives and attributes depending on the subject and the characteristics of the agricultural system under study. In addition, they do not justify the choice of objectives or attributes.

There have been many discussions around multifunctional agriculture in political and academic fields. For more than 10 years, discussion on agricultural policy has focused on multifunctional agriculture (Moreno, 2009), with countries in favor or against this new concept for legitimizing the maintenance of certain instruments that support the agricultural sector and the aids for farmers. The countries that defend multifunctional agriculture feel that this is a good model to follow and that it justifies encouragement for their agricultural sector. Those against it consider that it is only an idea to justify trade protectionism in agriculture.

Political debate has moved to the academic domain. From the theoretical point of view, studies have focused on discussion about the multifunctionality concept, given the need to limit the term, and to specify the supply of, and demand for non-commodity ecosystem services attributed to agriculture. From the applied point of view there is the need to quantify multifunctionality in order to define the policy instruments that can be legitimized.

Based on a review of scientific literature on the multifunctionality concept, we created a descriptive approach for the multifunctionality of agricultural systems by grouping their various functions and the goods and services that they provide, according to their economic (E), social (S) and environmental (EN) dime.

Public and private goods include: 1) farm land for crop production, such as real estate which is included in heritage or farmer goods; an increase in farm land values, and hence an increase in this heritage, has a direct effect on the agricultural enterprise business, which means more possibilities to access capital, and consequently improves and enhances investment possibility (Pascucci, 2007); 2) traditional economic activity moves towards the production of food and other agricultural commodities to be marketed; 3) recreation and amusement activities with the possibility of dedicating some surface areas, which are no longer being used for agriculture, to other activities that generate complementary income. These activities include rural tourism in the different forms it takes, ecotourism, scientific tourism, observation- and adventure-type tourism, wine-related tourism, and other activities such as bird watching and wildlife, hiking, cycling, fishing, hunting, and swimming; 4) biomass production energy.

Agriculture also generates positive externalities[1], such as: 1) creating natural heritage as a result of particular environmental conditions where farming takes place (climate, soil type and characteristics, soil properties, available water resources, terrain, etc.), farming practices, the production techniques applied and existing agricultural structures, thus converting it into a specific form of agriculture that is greatly appreciated by urban residents; 2) generating an agricultural landscape appreciated by society for conservation and preservation purposes; 3) preserving biodiversity through the diversity of ecosystems and ecological processes undertaken with agricultural practices, which has led to great wealth accumulated in form of biodiversity and ways of life; 4) protecting water resources in terms of the quantity and quality of the resources that can be used alternately for urban or industrial purposes; thus aquifer protection, sustainable aquifer use, alternative water sources for irrigation, etc., are necessary; 5) mitigating the impact of greenhouse gases through the fixation, reduction and storage of carbon and another greenhouse gases; 6) pasture and arable land have the groundwater replenishment and flood control capacities given their high water infiltration rates; 7) contributing to territorial balance and the possibility of scientific-cultural use thanks to certain agricultural activity elements (farmsteads, mills, irrigation infrastructures, practices, vocabulary, tools, etc.); and 8) protecting soil since agricultural activity plays a key role in both soil formation processes and soil conservation by favoring the accumulation of organic matter and soil fertilization by nutrient fixation.

Nevertheless, agricultural activity also generates negative externalities, *e.g.,* consumption of water resources. Irrigated agriculture uses significant amounts of water resources, which deprives water availability to other sectors and ecosystems. In some cases, aquifers can be overexploited, with very negative effects on surrounding ecosystems, which could even disappear. Irrigated agriculture and intensive livestock can cause major water quality problems through contaminated aquifers because of the accumulation of growing concentrations of leached nitrates. Evidently, more efficient irrigation technologies and practices to help minimize and correct diffuse sources of contamination are of interest. Another highlighted problem is the production of healthy/safe foods since irrigated agriculture, especially "Huerta de Valencia", is intensive as far as phyto-sanitary products, fungicides, weedkillers, insecticides and phyto-regulators are concerned. Then there are others of restricted use, *e.g.,* nematicides, acaricides, etc., which can cause major problems, such as waste remains on food, accumulation- and persistence-type problems in soil, and can affect water masses through leaching. The progressive restrictions in regulations on how such substances should be applied help reduce the use of them. Adopting good farming and livestock practices, and an agriculture model that complies with ecological production systems and integrated production, are necessary measures to comply with legislation, and to address

[1] Some externalities are associated with the public goods concept. The economic literature on multifunctionality indiscriminately talks about (positive and negative) externalities and public goods as most externalities are not depletable, are jointly consumed and impossible to exclude, which make them public goods. However, externalities emerge as a subproduct that is not directly sought, whereas in public goods, there is not enough incentive shown for an individual to produce them. Both can lead to market failures. In public goods, the answer would be provision by the public sector, while in externalities attempts are being made to provide incentives to private economic agents so they produce an adequate amount of externalities.

new food consumption trends of consumers concerned about food health, traditional production and varieties, crops offering an excellent quality flavor, traditional enviro-friendly tilling techniques, and family-run farms with traditional ways of life and production in a nearby agricultural area with good quality of life.

We believe that the AHP methodology is relevant to socially assess the functions that agricultural systems perform in their various (economic, social and environmental) dimensions as it offers us the means to measure demand on a non-monetary scale. Applying this methodology to social preferences analyses provides results that can be interpreted and validated in social utility functions terms by measuring, in our particular case, the priorities of the various affected social groups by analyzing the relative importance that society as a whole attaches to these functions.

The main objective of our hierarchy is to MAXIMISE the UTILITY which the Agricultural System provides society with. According to this objective the second level of the hierarchy which represents decision CRITERIA and SUBCRITERIA is formed by aspects that determine the functionality of agricultural systems. Following the proposed outline in the functionality analysis of agricultural systems we differentiated the possible FUNCTIONS supplied according to their economic, social and environmental dimension. This outline coincides with the general approaches by Saaty (1997) to apply the analytical-hierarchical process to decision making in public policies.

Based on the outline of the functions, goods and services shown in Table 1, we established a coherent hierarchy with a limited number of criteria and subcriteria by grouping and specifying them in order to provide necessary and sufficient information to obtain as much consistency as possible.

All the criteria and subcriteria were guided in the decision process to express scores only in terms of "more or better", and to make negative externalities become desirable functions: supply of quality water resources and healthy/safe foods. Aggregation of the various subcriteria, functions in our case, was done with those identical in nature which can be undertaken together to avoid too much information for decision makers who, otherwise, tend to ignore some less important objectives and deal with others incoherently. Table 1 presents a list of these functions and Fig. 1 depicts the outline of the proposed hierarchy.

Quantification of social demand can be done through the social well-being function based on monetary units (monetary evaluation) or by determining the social utility function (utility evaluation). Multicriteria techniques, such as AHP, can help determine the Social Utility Function (SUF) by evaluating the priorities of the various social groups affected by the analysis of the relative importance that society as a whole attaches to different functions (Duke & Aull-Hyde, 2002; Hall *et al.,* 2004; Reig, 2007). Having obtained the SUF composition, it reflects the relative importance that society attaches to the various functions that agricultural systems can perform. Just as society as a whole must attribute weightings with assessment purposes, quantification must be done on a representative society sample. This sample is determined from an adult population in a given geographical area that is limited depending on the agricultural system and whose public goods and services are the object of the social preferences study.

The geographical area in our study is the city of Valencia and the metropolitan area around the city, the fringe where the "Huerta" is located.

A survey on the "Huerta de Valencia" agricultural system was conducted with a representative sample of residents in Valencia and its metropolitan area weighting distribution by municipalities, gender and age according to the 2011 Municipal Census data published by the Valencian Statistics Institute (VSI).

The people in the sample group expressed their value judgments or preferences at each hierarchy level. Based on our proposed hierarchy (Fig. 1), by indicating their preferences, individuals generated four matrices from which the composition of the individual utility function was determined. Saaty proposed a scale that allows the individuals to make pair-wise comparisons, show their preferences and also quantify how strongly they prefer a function over another with which it is compared (Table 2). With the individual preferences and/or priorities the SUF composition was determined which reflects the relative importance that society attaches to the various functions that agricultural systems can perform.

The number of individuals in the sample group was determined by following the recommendations for conducting social-type studies: finite population, confidence level of 95%, the ratio value of 0.5 in the population, and sampling error of 5%. In accordance with population size the minimum sample size had to include 384 individuals. In order to acquire representative results from the series a sample of 413 individuals from the study area was obtained, who were all aged over 18

Table 1. Functions, goods and services of the "Huerta de Valencia" agricultural system

Generic services	Functions	
0. Soil	Heritage	Guaranteeing agricultural income
1. Production of foods	Primary production of food products and other agricultural commodities to be marketed	Supplying healthy, safe agricultural products
2. Recreation	Activities relating to recreation and amusement	Promoting opportunities for alternative income
3. Production of energy	Production of biomass for energy	Contributing to conserve a quality agricultural landscape
4. Shaping Natural Heritage and Creating New Landscape Forms	Shaping a particular crop system that helps shape a unique characteristic agricultural system and to conserve plant cover that helps create a highly valuable characteristic agricultural landscape	Contributing to protect and conserve biodiversity
5. Preservation and conservation of biodiversity	Environment for animal and plant populations	Contributing to increase the supply of water resources
6. Protecting water resources	Storing and retaining water Releasing resources by saving and improving irrigation efficiency Controlling diffuse sources of contamination	Contributing to conserve the quality of water resources
7. Mitigating greenhouse gas emissions	Greenhouse gas sink Reducing emissions Regulating the atmosphere's chemical composition	Contributing to CO_2 absorption Contributing to improve air quality
8. Mitigating the impacts of disasters caused by floods, slides and droughts, etc.	Regulating water flows Retaining sediments and controlling erosion	Contributing to mitigate disasters caused by floods, slides, droughts, etc.
9. Cultural	Territorial balance Cultural use Scientific use	Contributing to manage population centres and avoid congestion Contributing to improve employment and labour Contributing to create and conserve cultural-scientific heritage
10. Protecting soil	Soil formation process Soil conservation	Contributing to protect soil

years and answered the survey, thus reducing the sampling error below 5%. A specific 4-part questionnaire was devised for this purpose. The first part included information about the "Huerta de Valencia" and its functionality. In the second part, data were requested for the socio-demographic and economic characterization of the individuals interviewed. The third part informed about the system used to consult preferences, with indications as to how to answer the questionnaire. The final part included the questions.

Residents of Valencia and its metropolitan area were interviewed in autumn 2012, from mid-November to mid-December, by a company specialized in conducting social studies (EIXAM), so they could indicate their preferences for the functions that the "Huerta de Valencia" can perform. Interviewers requested people's participation and, if they accepted, they briefly explained the questionnaire. They informed participants about the first part of the questionnaire on the functions, goods and services that this agricultural system can supply. Participants were able to consult and check these documents during the interview to help them complete the questionnaire. Interviewers helped the respondents so that they could answer all survey questions.

The Saaty scale of values was illustrated in each pair-wise comparison. Colors were used to help decision makers explain the functions compared in each

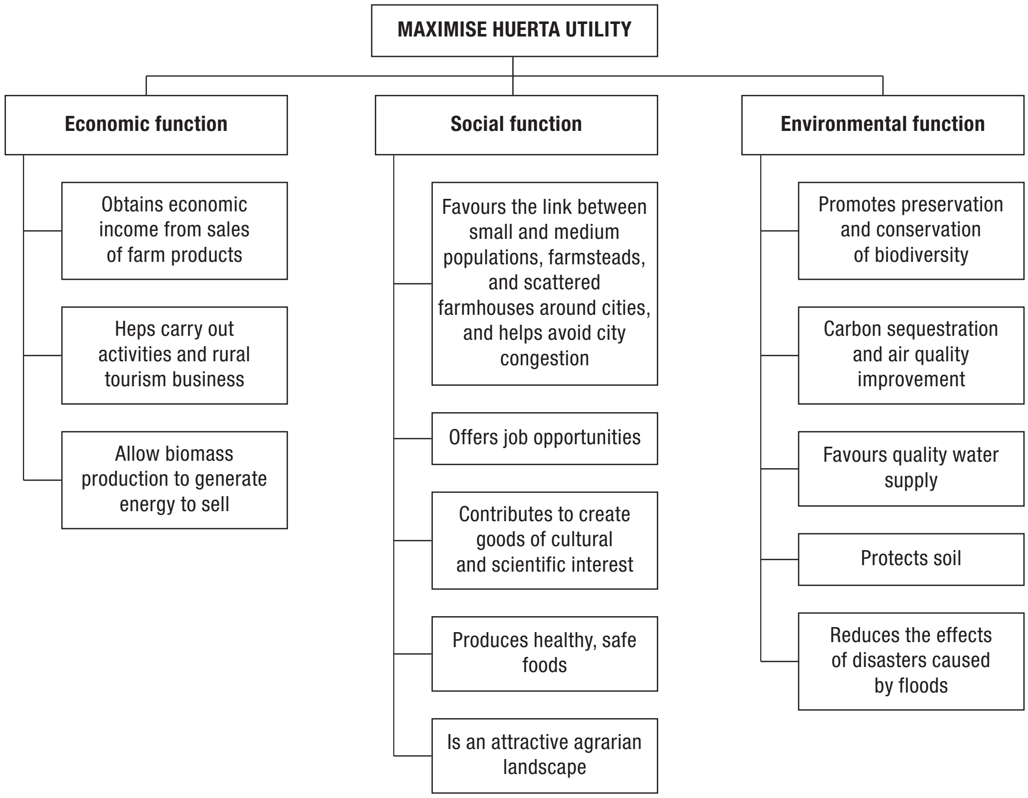

Figure 1. Hierarchy.

case and to make decisions on the preferred function and the intensity of that preference. The intention was to help decision makers voice their opinion or preference intuitively and simply to help them quickly identify the functions being compared, and to define their preference, and its intensity for a certain function (see Fig. S1 [pdf online]).

Results

Using the matrices with the individual preferences, the priorities of each individual were calculated according to the various functions. The priorities calculation was done following the Eigenvector Method (EM).

$$\mathrm{A} \times \mathrm{W} = \lambda_{max} \times \mathrm{W} \quad [1]$$

Table 2. Scale of Saaty for pair-wise comparisons

1	Equal importance	=
3	Weak dominance	+
5	Strong dominance	++
7	Demonstrated dominance	+++
9	Absolute dominance	++++
2,4,6,8	Intermediate values	

The first step was to obtain the representative weights of the interviewees who represented society in the study area at the same time, and to also determine the SUF. Each interviewee generated its Saaty matrix, A_k, where a_{ij}, is the result of comparison of criteria i with criteria j:

$$\mathrm{A_k} = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \vdots & \vdots & & \vdots \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{bmatrix} \quad [2]$$

$$w_i / w_j = a_{ij} \ \text{ all } i,j \quad [3]$$

$$\mathrm{A} = \begin{bmatrix} \frac{w_1}{w_1} & \frac{w_1}{w_2} & \dots & \frac{w_1}{w_n} \\ \frac{w_2}{w_1} & \frac{w_2}{w_2} & \dots & \frac{w_2}{w_n} \\ \vdots & \vdots & & \vdots \\ \frac{w_n}{w_1} & \frac{w_n}{w_2} & \dots & \frac{w_n}{w_n} \end{bmatrix} \quad [4]$$

$$W = (w_1, w_2, \dots, w_n)^k \quad [5]$$

The objective was to find the vector of priorities W where $\frac{w_i}{w_j} = a_{ij}$

The first issue to solve was how to aggregate individual judgments to obtain the social function. We can first aggregate individual preferences to obtain society's total preferences, and then calculate social priorities, or we can calculate the individual priorities which are then aggregated to obtain social priorities. As a generally accepted rule in the literature, aggregation of individual priorities is done when individuals participate as separate individuals, and the aggregation of judgments on preferences is carried out when individuals form a more or less homogeneous group.

Forman & Peniwati (1998) consider that when interviewees act in their own right and with different value systems, we must be concerned about the priorities resulting from each one, and aggregate individual priorities rather than preferences. Based on these recommendations, we proceed with the method to aggregate individual priorities (AIP) in order to calculate the SUF and obtain social priorities with the individuals in the sample group.

$$W = [w_i] = \sqrt[m]{\prod_{k=1}^{k=m} w_{ik}} \qquad [6]$$
$$w = (w_1, w_2, \ldots, w_n)$$

Adding individual priorities implies having to previously verify that the people in the sample group answer the survey separately and individually in their own rights. This verification is carried out by studying the heterogeneity of the interviewees' preferences.

Before proceeding with the aggregation of priorities or preferences, the analysis of the consistency of the judgements, indicated by each interviewee, must be done in order to determine the individuals in the sample group from which the SUF is established.

Aggregation was done by the Row Geometric Mean Method (RGMM) (Aczel & Saaty, 1983; Easley *et al.*, 2000; Saaty & Vargas, 2005; Aull-Hyde *et al.,* 2006).

Four hundred and thirteen people answered the questionnaire, but only 404 filled in all the matrices. The priorities of those 404 people were calculated. The rest were eliminated to avoid a possible strategic bias of those who did not indicate their preference for some functions, which could affect the overall result.

If groups of decision makers are relatively small, a way to get a single group of preferences from which priorities can be obtained is to use debate and consensus. Indeed Moreno-Jimenez *et al.* (2006) distinguish three feasible situations in group decision making: i) a decision group in which all individuals share a common objective; ii) negotiated decision, in which each individual solves the problem on their own, and a greements and disagreement zones are sought among the different positions; iii) systemic decision, when each individual acts independently, but all the positions are reached according to the principle of tolerance. In general the consensus in decision processes is practically impossible to obtain when the number of comparisons to be made and the number of people increase. In social preferences studies the desirable decision making framework is highly plural. In any case, a large number of participants is important for the sample to be representative, and for all the strata of interest referring to socio-economic variables (income, age, population and level of education) to be represented in it. In this context, SUF cannot be determined as a result of the process in which individuals seek a common solution, or a consensus, which is reached according to the principle of tolerance and by overcoming any disagreements between decision makers. Conversely, and given the large number of people, they all indicate their preferences individually and independently. Then preferences are aggregated using mathematical methods to obtain priorities which do not represent any particular individual in the group.

Alternatively, a representative sample of society may include individuals whose preferences cover the whole range of possible values, from 1/9 to 9, in all the pair-wise comparisons made. It is for this reason that all preferences can be represented in the sample.

Heterogeneity of preferences was analyzed using a frequencies analysis of each pair-wise comparison made of the functions that the "Huerta de Valencia" can perform. When analyzing the tables of frequencies corresponding to each pair-wise comparison of the functions, we checked that the some interviewees' preferences were in the complete range of possible values, from 1/9 to 9, in all the pair-wise comparisons made. The statistical tests did not exclude the hypothesis that interviewee-reported preferences were uniformly distributed within the considered range. Consequently, the existence of separate decision makers must be considered, and it is necessary to calculate their priorities to aggregate them in order to obtain social priorities.

The coherence of the preferences of each interviewee was studied based on the so-called "individual consistency", which should be taken into account in order to consider whether individual opinions are valid for determining the SUF. The consistency analysis requires calculating the "Consistency Index" (CI) of Saaty for each preference matrix.

$$CI = \frac{\lambda_{max} - n}{n - 1} \qquad [7]$$

The "Consistency Ratio" (CR) is calculated from CI. CR is a ratio between the CI and RI:

$$CR = \frac{CI}{RI} \qquad [8]$$

where RI is the average value of CI of pair-wise comparisons matrices of the same order randomly obtained. When CR is less than 10% (0.1), the matrix is considered offering acceptable consistency. Saaty calculated the random indices of RI for different matrix sizes to obtain CR. Other researchers have carried out similar simulations to those performed by Saaty, but with a different number of matrices, or incomplete matrices. Hence array indices may differ, but all converge to Saaty's values[2].

In our research only 29 interviewed people presented an acceptable inconsistency level for all four matrices, of whom three were seen to be completely consistent. We wondered if we could determine the utility function of the "Huerta de Valencia" from these 29 participants. A priori it would be completely inappropriate given the theoretically minimum sample size which, according to the population characteristics and the margin of error, was estimated at 384 individuals. We also checked the participants' socio-economic characteristics; all 29 individuals reported having finished higher education, of whom 80% had university studies.

Therefore the interviewees in the group with an acceptable consistency ratio could not ensure that all the strata of interest for level of education or age are represented. Based on their socio-economic characteristics, these people represent a specific group whose preferences cannot be considered as representative of society as a whole.

A high inconsistency level may bias the results. Irrespectively of the method used to measure inconsistency, the most important aspect in research processes in which AHP is applied is how to interpret it, and whether this level can be lowered to obtain acceptable values.

Therefore it is interesting to know the appropriate sample to use in the aggregation process. Saaty believed that some inconsistency can be considered, and that this could even be a good thing. He justified this by stating that when people indicate their preferences, they come across difficulties in quantifying or accurately measuring their preferences, particularly in the case of intangibles. Accordingly, studying preferences can be considered with a representative sample of society made up of people who are more or less familiar with the measurement scale.

As it was not possible to reconsider judgments because of sample size and the questionnaire format, given the large number of comparisons to be made, and as people have more or less skills/difficulties in making pair-wise comparisons and indicating their preferences for several functions, it is possible to find certain intransitivity in individual judgments and, therefore, a certain degree of people's inconsistency.

If we also bear in mind the importance of sample representativeness, it is worth questioning the no consideration of interviewees with consistency ratios that are not acceptable a priori. Accordingly, the effect of consistency on the resulting utility function was studied to verify whether the inclusion of interviewees with higher CR than the acceptable value could have a significant effect on the decision process results.

In order to study how the consistency affects the resulting utility function, the effect of including interviewees with an inconsistency above the acceptable level was verified. Beginning with the utility function obtained by aggregating all the interviewees (404), we progressively eliminated those interviewees whose inconsistency level was above an established value, and then we calculated the weights by aggregating the priorities of the interviewees who remained (see Table 3).

Preference for the economic function remained around 38.5% for the interviewees with a different inconsistency level, which ranged from those presenting an inconsistency level that came close to acceptable levels to those with very inconsistent levels. Only when considering interviewees with an acceptable inconsistency level the weight of economic function was substantially lower, by around 30%. Preference for the environmental function was approximately 34%, which slightly increased when inconsistent questionnaires were progressively eliminated, but rose substantially to 42% when only those individuals with an acceptable consistency level were considered. The weight of the social function changed slightly as interviewees were progressively eliminated. When considering tho-

[2] See Ishizaka & Labib (2011).

Table 3. Social utility function by level of inconsistency of individual judgments (EM) that are added (AIP) (%)

		Generic functions			Economic function			Social function					Environmental function				
CI	N	wE	wS	wEM	wEI	wT	wEng	wCity	wJob	wC&S	wSF	wAL	wBIOdv	$wSCO_2$	wQH_2O	wPrtSoil	wRdist
CR < 0.1	29	30.3	27.2	42.5	16.6	6.6	7.1	4.5	7.0	4.8	6.9	4.1	9.5	9.1	6.8	10.0	7.0
CR < 0.2	84	38.4	24.7	36.9	22.8	8.2	7.3	4.1	6.8	4.3	6.1	3.4	8.5	8.7	6.2	7.9	5.6
CR < 0.3	168	38.3	25.8	35.8	23.7	7.6	6.9	4.0	6.7	4.6	6.7	3.8	7.5	8.9	6.3	7.9	5.2
CR < 0.4	226	38.2	25.9	35.9	23.5	7.4	7.3	3.9	6.8	4.7	6.7	3.7	7.4	9.0	6.6	7.7	5.2
CR < 0.5	277	37.6	26.4	36.0	23.3	7.2	7.0	4.0	6.7	4.7	7.0	3.9	7.2	8.1	6.7	7.8	5.4
CR < 0.6	324	37.6	26.8	35.6	23.3	7.3	7.1	4.0	6.9	4.8	7.1	4.0	7.0	8.9	6.9	7.6	5.3
CR < 0.7	344	38.5	27.1	34.3	24.0	7.3	7.2	4.0	7.2	4.8	7.2	4.0	6.5	8.6	6.7	7.3	5.1
CR < 0.8	352	38.8	27.0	34.1	24.3	7.4	7.2	4.0	7.2	4.7	7.2	4.0	6.5	8.5	6.7	7.3	5.2
CR < 0.9	362	38.5	27.2	34.2	24.0	7.2	7.1	4.1	7.1	4.8	7.2	4.1	6.5	8.5	6.8	7.4	5.2
CR < 1	369	38.7	27.0	34.2	24.0	7.4	7.1	4.0	7.2	4.7	7.2	4.1	6.5	8.5	6.8	7.4	5.2
CR < 1.25	378	38.7	26.9	34.3	24.4	7.4	7.1	4.0	7.0	4.7	7.1	4.0	6.5	8.5	6.9	7.4	5.1
CR < 1.5	388	38.9	26.9	34.1	24.4	7.4	7.1	4.0	7.0	4.7	7.1	4.1	6.5	8.5	6.8	7.4	5.0
CR < 2	395	38.6	27.2	34.2	24.2	7.4	7.0	4.0	7.1	4.7	7.3	4.1	6.4	8.4	6.9	7.4	5.0
CR < 3	398	38.4	27.4	34.2	24.1	7.3	7.0	4.0	7.1	4.8	7.3	4.1	6.4	8.4	6.9	7.4	5.0
CR < 4	399	38.4	27.4	34.2	24.1	7.3	7.0	4.0	7.1	4.8	7.3	4.2	6.4	8.4	6.9	7.4	5.0
CR < 5	403	38.4	27.4	34.2	24.1	7.3	7.0	4.0	7.1	4.8	7.4	4.2	6.4	8.4	6.9	7.4	5.0
100%	**404**	**38.5**	**27.5**	**34.1**	**24.1**	**7.3**	**7.0**	**4.0**	**7.1**	**4.8**	**7.4**	**4.2**	**6.4**	**8.4**	**6.8**	**7.4**	**5.0**

CI: Consistency Index. CR: Consistency Ratio. E: economic. S: social. EM: environmental. EI: economic income from sales of farm products. T: rural tourism business. Eng: biomass production to generate energy to sell. City: Favours the link and helps avoid city congestion. Job: Offers job opportunities. C&S: Create goods of cultural and scientific interest. SF: Produces healthy, safe foods. AL: attractive agrarian landscape.; BIOdv: Promotes biodiversity. SCO_2: Carbon sequestration. QH_2O: quality water. PrtSoil: Protects soil. Rdist: reduces effects of disasters caused, etc.

se with an acceptable CR, the preference levels obtained were similar to the case with all the interviewees.

Comparable results were obtained for the economic function since the aggregated priorities were similar, irrespectively of the inconsistency level. However, they differed when interviewees had acceptable inconsistency levels. The economic income generation function predominated with a weight of over 60%, which went below 55% when only the individuals with acceptable CR are considered, for which the alternative income function obtained from the generating energy service was more important than tourism.

Variations in the aggregated weights for the social function slightly differed within the complete range of consistency ratio. Irrespectively of interviewees' inconsistency levels, utility functions were similar, but differed from those presented by individuals with acceptable inconsistency levels.

Differences between interviewees' priorities for the explicative functions of the environmental function were also found if compared to the various inconsistency levels and individuals with an acceptable CR.

When analyzing the SUF of the various inconsistency strata, the obtained SUF was practically identical regardless of the inconsistency level considered. Differences in the value of the weights between the various strata were noted, which did not exceed 2%. The most marked differences were found between the SUF of the whole sample and the social function of those with an acceptable consistency ratio. These differences were presented in the weight conferred to the economic and environmental functions, the economic function of obtaining agricultural income, and the functions of an environmental nature, while a loss was noted for the economic functions favoring the environmental functions. In principle, we cannot attribute this fact to the inconsistency level, but to the effect of the group from which the interviewees with acceptable inconsistency levels were extracted as they presented exceptional socio-economic characteristics, as mentioned earlier.

Discussion

The first differentiation among functions, according to their economic, social and environmental dimensions, was made after considering the multifunctionality definition proposed by the EC (1999). The EC established that the main European agriculture functions were production of raw materials and food under competitive conditions, conservation of the natural environment and rural landscapes, as well as contribution to feasibility of rural areas and to balanced territorial development. This definition is too broad and ambiguous to attribute to agriculture other functions that are related to other different goods and services, apart from agricultural-based foods and raw materials, and it has never been specified and defined in a regulation framework. The economic function has been clearly identified with the traditional function of producing foods and other raw materials, and the environmental function with the positive and negative externalities generated in production processes. Nevertheless, the social function encompasses aspects as diverse as socio-economic, political and cultural aspects attributable to agricultural systems (food safety, employment, local development, territorial planning, etc.) (Massot, 2002). Some authors refer to this category as a territorial function (Álvarez, 2003).

The reformulation of the Common Agricultural Policy (CAP) objectives to incorporate the multifunctionality would have required defining the objectives for all agriculture functions. However, these objectives are not identical for all the regions and production systems because all of them offer a different combination of production resources which will contribute different functions the society (Tió & Atance, 2000). From this point of view, interventions should be done on a zonal level and multifunctionality should be studied from a territorial scale to differentiate the characteristic agricultural systems, which have been defined by indicators and agricultural variables (Silva, 2010).

Wilson (2007) criticizes that the multifunctionality term is a broad and confusing conceptualization, depending on the research field, from agricultural economy, geography and including rural sociology. It distinguishes between the multifunctional agriculture concept (Van Huylenbroeck *et al.,* 2007), related to economic sense, and multifunctionality from a wider perspective of landscape and ecology (Brandt & Vejre, 2004), based on broader and holistic interpretations. In the first case, agriculture is an economic activity and the joint production of market products (foods and raw materials) with other goods and services, which results in a positive approach to multifunctionality. In the second case, there are-links between socio-cultural processes and rural development, and these links are the outcome of the plurality of the objectives contemplated in the agricultural policy, hence a more regulatory approach is generated.

According to Moreno (2009) multifunctionality per se does not exist, but corresponds to a particular way of conducting agriculture that moves away from productive models with greater integration in the region and a greater capacity to contribute to rural development.

Zasada (2011) shows the existence of significant scientific contributions around-groups of functions and services that agriculture provides, which constitute the economic, social and environmental dimensions of sustainability. This author highlights the conceptualization of Wiggering *et al*. (2003) based on the sustainable development paradigm developed as a theoretical framework to face post-productivism changes. According to this author the intention of introducing the multifunctionality concept is to spatially and temporally integrate the traditional food production activity with other uses, including aesthetic and recreational uses, nature conservation and water balance.

Reig (2007) explores the possible connections between multifunctionality and sustainability. The multifunctional agriculture orientation that leads to adopting measures to correct market failures and cover certain environmental-type functions (protecting biodiversity, landscape, etc.) can also improve social wellbeing, reinforcing environmental sustainability in order to help undertake more sustainable agricultural activity.

Gómez-Villarino & Gómez-Orea (2012)[3] establish that, depending on the basic functions that the natural environment fulfils as a source of resources, a receiver of effluents and a supporter of activities, sustainable agriculture will move closer to the traditional exploitation of renewable resources in accordance with its renovation rates, will not produce emissions to the environment beyond its assimilation capacity, and will respect the collection capacity of ecosystems when they undergo changes. This work specifically states that sustainable agriculture will promote the efficient use of inputs (water, energy, soil) to avoid the introduction of other elements into the air, water or soil, applying integrated or ecological production techniques. At the same time, it will promote territorial ba-

[3] See also Gómez-Orea (2001).

lance, the creation of a social system around the activity and the implementation of more productive infrastructures and economic activities to respect the nature of different ecosystem types.

Moyano (2008) attributes multifunctionality a double meaning, agricultural and territorial, considering multifunctionality as a result of the evolution and dynamics of agricultural policies toward new approaches and its integration in European rural development initiatives. This author defends the need of a modern, competitive agricultural sector based on the production of healthy, safe and environ-friendly foods, improving the organization and management of agricultural activity, and diversifying risks to generate employment and wealth, the basis for the permanence of farmers. At the same time this modern and competitive agricultural sector should be integrated into the territory and guided by the concept of multifunctionality to develop a dynamic rural world. The author bases this principle on the effects that agriculture has on the land to favor the conservation and maintenance of the environment, landscape and territory due to the maintenance of farms in the context of sustainable agriculture with only positive externalities. This is also based on the growing value that society gives to natural and cultural goods in the rural area and the demand for using and enjoying rural territories as places for recreation and entertainment purposes.

Abbler (2001) proposes a general classification of non-commodity goods and services (NCGS) which are grouped into positive or negative externalities. There are seven positive externalities: landscape and natural areas, improving biodiversity, conserving cultural heritage, feasibility of rural economies, improving food safety, preventing natural risks and recharging aquifers; and six negative: loss of biodiversity, polluted waters, soil erosion, deteriorated animal well-being, irrigation and overexploitation of aquifers, and greenhouse gas emissions.

Under this approach, Kallas *et al*. (2007) select the most relevant aspects of agriculture: biodiversity, feasibility of rural economies, overexploiting aquifers and their contamination, landscape and natural areas, agricultural soil erosion and preventing natural risks.

Gómez-Limón & Barreiros (2007) describe the agriculture functions in different case studies, considering a) the supply of social goods and services, maintenance and dynamism of rural communities and protection of cultural heritage and b) the importance of environmental functions, particularly limiting runoffs and erosion, providing traditional agricultural landscapes and maintaining ecological diversity.

Reig (2008) considers that agriculture produces a wide range of goods and includes a summarized outline that classifies them as public and private goods. Private goods include producing foods and raw materials of agricultural nature, rural tourism and other goods. Public goods are classified as 1) environmental: protecting landscape values, biodiversity and soil as well as controlling erosion, and 2) social: contribution to the viability of disfavored rural areas, protecting rural cultural values and protecting against rural population drifts.

The proposed descriptive approach of the multifunctionality of agricultural systems is the result of considering the previous opinions. Therefore, the development of the study of multifunctionality of any agricultural system requires the definition of the main indicators that adequately explain the underlying processes and relations linking agricultural activity, the functions and goods and services that it supplies. These indicators should be defined and proposed in each case study in accordance with the most relevant aspects of the agricultural system and also with the aim of the study, but basically in accordance with existing sources of information.

Madureira *et al.* (2007) show in their review about the valuation of goods and services supplied by agriculture that there are many works that have studied the demand of certain functions, goods and services supplied by agriculture. However, these authors report the few empirical studies that have analyzed social demand in favor of multifunctional agriculture from an overall perspective (Gómez-Limón, 2006; Gómez-Limón & Barreiros, 2007).

With this research we have assessed and found a social concern about the "Huerta de Valencia" and its conservation and maintenance. In fact 65% of respondents were interested in the maintenance and conservation of this agricultural area. This particular social interest is specified as social preferences for the functions, goods and services that this agricultural area can provide, and it determines their SUF. Accordingly, the economic function is the most relevant one with a relative weight of 38.5%. Within this function we find the generation of agricultural income resulting from the production of foods and other raw materials of agricultural nature to be commercialized in standard markets as the most important function, with a weight of 24.1%, among not only the economic functions, but also among the remaining explicative functions. Importance of over 10% is not attached to any other explicative function. Tourism activity, job creation, producing healthy/safe foods or CO_2 absorption are the functions that follow in order of preference with a weight of around 7% each. Evidently for the Valencian society, the "Huerta de Valencia" still makes economic sense as far as agricultural production is concerned.

As can be expected several socio-economic groups show different social preferences and utility functions of the social groups that are defined according to their socioeconomic characteristics, although the weight of agricultural income generation is important in all of them. For future research it is interesting to define utility functions for different social strata, establish more or less homogenous groups and determine the systematics aggregation of preferences or priorities.

The Eigenvector Method (EM) was proposed to calculate individual priorities, but the Row Geometric Mean Method (RGMM), one of the most widely used methods, was also considered for the same reasons that justify the use of EM. It also provided an index to quantify the inconsistency level of all the interviewees when they indicated their preferences. It is interesting to identify the non-significant differences between the SUFs that result from each case.

No matter what method is employed to calculate priorities we should highlight that it is necessary to check the independence of the individuals who participate in the questionnaire and determine the method used to aggregate individual preferences. The present work previously analyzed the heterogeneity of individual preferences, but several authors have proposed other methods. In fact, Saaty proposes a measure of the dispersion of preference judgments reported by different individuals, or consensus indicator for consideration of groups of individuals who are not homogenous. Future works can deal with this issue.

Perhaps one of the most interesting issues to have arisen in the present work is the analysis of individual inconsistency and the effect of incorporating inconsistent individuals into SUF calculations. For the particular "Huerta de Valencia" case study we verified that those interviewees with acceptable inconsistency levels are not representative groups of society, from which the SUF is determined, and that if inconsistent individuals are included in the utility function, the SUF does practically not change when individuals have low levels of inconsistency (0.2 or 0.3), or when these levels are higher, which is the case of the population sample in the present work.

Acknowledgements

The authors acknowledge the support received from the Spanish Ministry of Economy and Competitiveness through the research project "Multiple Criteria and Group Decision Making integrated into Sustainable Management" (Ref. ECO2011-27369).

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